D.F. Wentworth J.K. Couchman J.C. MacBean A. Stecher

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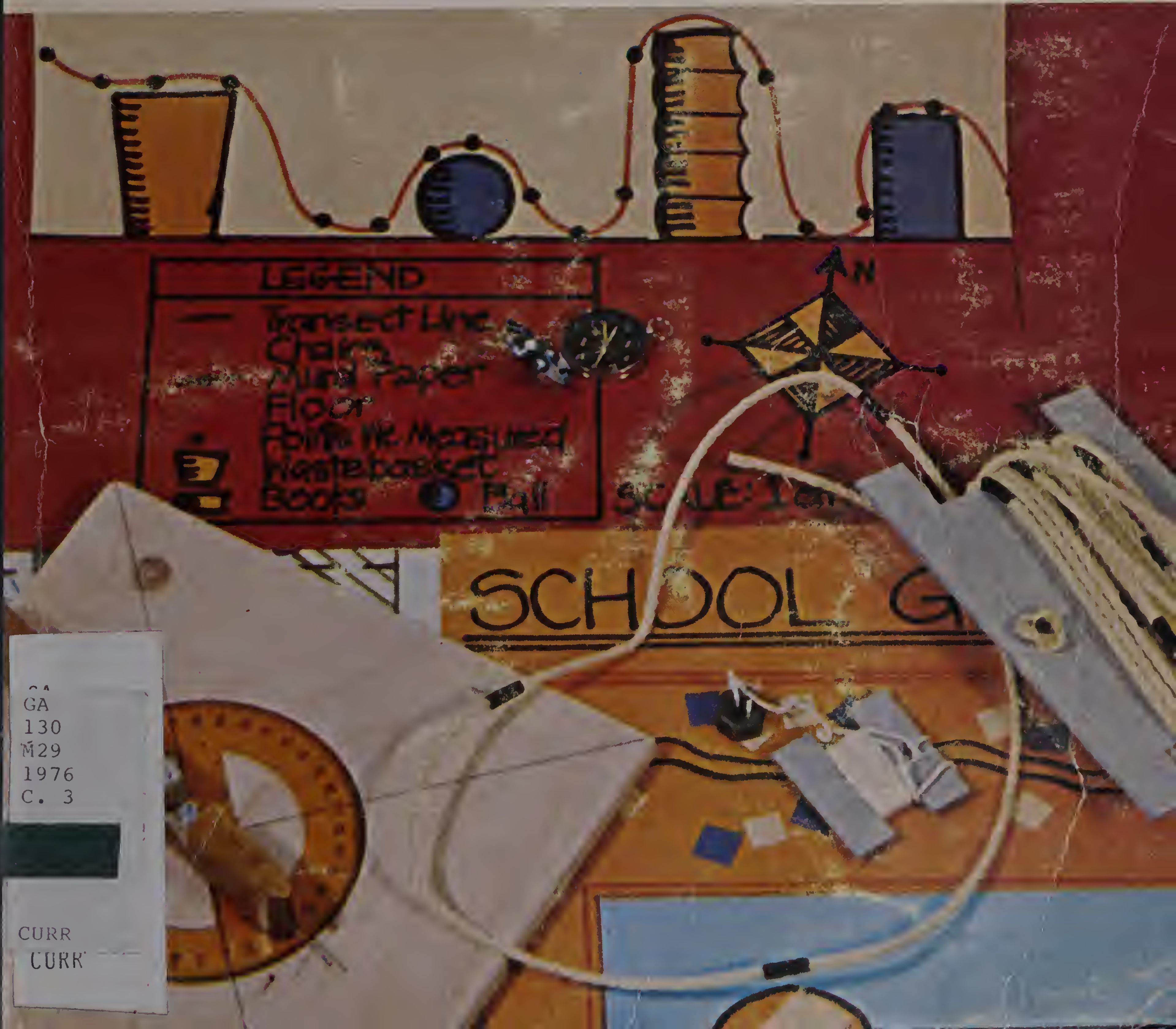
Mapping Small Places

Examining Your Environment



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Mapping Small Places

Examining Your Environment

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Toronto

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Introduction

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Introduction

Mapping is one very useful method of recording information about your environment. In addition to showing data, a map has an advantage over charts and graphs in that it can be used to accurately indicate where the information was collected. Often several sets of data can be placed on the same map so that comparing information is made easier. In this and other ways maps can be used to help you to answer questions or to solve problems.

To the authors, a map is a method of accurately locating on a flat surface a variety of objects or information about those objects. The authors believe that mapping should not be thought of as belonging only to geography but should be used any time that a map is the best method to use to record information. The making of maps can be an interesting way to record many of the things occurring right in your own backyard, school grounds, or neighborhood vacant lot.

The purpose of this book is to provide the skills that you will need in order to make your own maps. To guide you in the map making, some activities have step-by-step instructions and plans for making simple equipment. Construct a piece of equipment, and then use it to collect some data. Record this data in chart form or on a sketch according to the directions you are given. Next follow the suggestions provided in order to draw your own map. Finally, use your map-making experience to answer the questions in the Digging Deeper section. The answers to these questions will guide you to a better understanding of what you have learned and also help you to make better maps.

You should do Chapter 1 first so that you will get to know about the important parts of maps and the ideas behind what maps try to show. You will need these details in order to draw the maps from the data you collect in the other activities.

At first, the maps that you will be making will be very simple ones. Gradually, they will become more complicated as you improve your mapping skills. Many of the ideas presented in the earlier activities will be needed in the later ones. If you feel that you already know much about map making, quickly scan through the first chapters until you find a starting point more in keeping with your skills.

Your mapping experiences will begin indoors. Here, you can master the techniques and try out your equipment before proceeding outside. Sometimes the areas that you will be measuring will be very small areas such as cracks in the pavement. At other times, your investigations may require the exploration of areas as large as your school grounds. Do not feel that you must do every investigation. Instead, select the ones that interest you the most.

In the *Branching Out* sections, there are several suggestions for other maps that you can make. Here is an opportunity for you to apply your new skills and find out new things on your own. Probably, you will have many ideas that are more interesting to you than those suggested. Do not hesitate to pursue what interests you!

Once you have completed your maps, show them to other people. Ask them to tell you what they like about them and what they think the map tries to show. You may even ask them for suggestions you could use in improving your maps.

Keep in mind that accurate map work requires much concentration and a lot of careful measurement. If you take your time and do the best job that you can, you should be very pleased with the results.

Many of the map making skills that you will learn in this book are very much like the methods used by scientists to obtain the information they need in order to find out more about things.

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Comparing Maps

1

1. Comparing Maps

Activity 1:

What is a map?

Imagine that it was necessary for you to explain precisely what a map was to a visitor from outer space. This visitor can understand your language, but he has never heard about maps before. Write down the exact words you would use. These words are your definition of a map. Collect as many definitions of maps as you can from your friends, relatives, and teachers. Look up the definition of "map" in several different dictionaries, and add these to your list. Read the authors' definition of a map in the introduction to this book. Compare the definitions that you obtained.

From what other sources could definitions of maps be obtained?

Digging Deeper

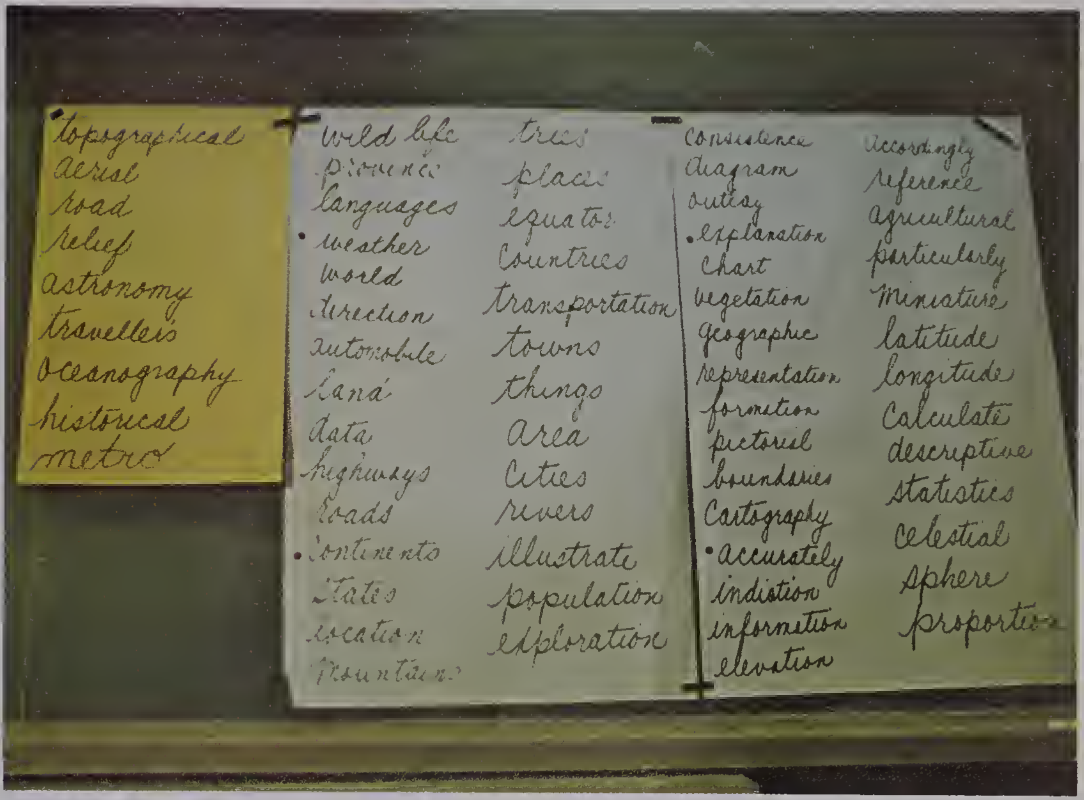
Which definition on your list came the closest to matching your definition?

In your opinion which definition was the most unusual?

Count to find how many of the definitions that you collected contained each of the words or ideas in this chart.

What other ideas not included in this list were mentioned in the definitions?

Words or Ideas	Times Used
locating something	
the earth's surface	
information	
accuracy	
streets and roads	
a piece of paper	
boundaries	
finding one's way	
proportion or scale	
lakes and rivers	
two or three dimensions	
geographers or explorers	



topographical
aerial
road
relief
astronomy
travellers
Oceanography
historical
metro

wild life
province
languages
• weather
world
direction
automobile
land
data
highways
roads
• continents
states
location
mountains

trees
places
equator
Countries
transportation
towns
things
area
Cities
rivers
illustrate
population
exploration

Consistence
diagram
outlay
• explanation
Chart
vegetation
Geographic
representation
formation
pictorial
boundaries
Cartography
• accurately
indistion
information
elevation

Accordingly
reference
agricultural
particularly
Miniature
latitude
longitude
Calculate
descriptive
statistics
Celestial
sphere
proportion

What other changes would you make in your definition now in order to improve it?

How is a map different from a picture and a globe?

Which words about maps in this list are familiar to you?

Branching Out

Look up the meaning and origin of the words *chart* and *cartography*. If necessary, obtain the assistance of a librarian. How did the words, chart and map, come to mean the same thing? In what ways are charts still thought of as being the same as maps today? Who would be most likely to refer to a chart as being a map? How are the charts you would make in school different from most maps?

Activity 2:

What do maps try to show?

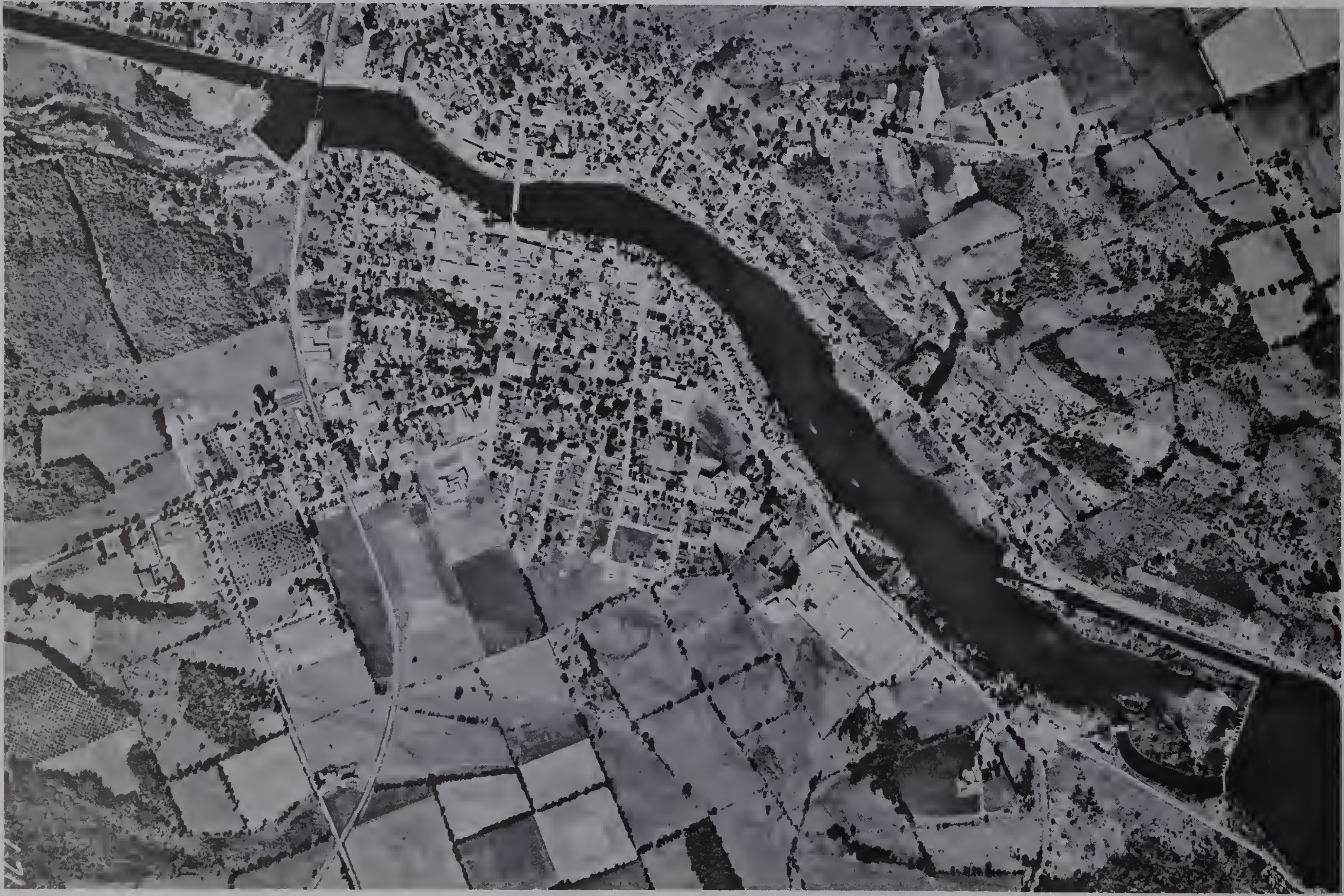
A map is a special way of looking at something. Examine the photograph and the map on these two pages. The photograph was taken from an airplane flying at an altitude of 2400 m. The photographer aimed his camera straight down at the ground. Can you see houses, trees, and streets?

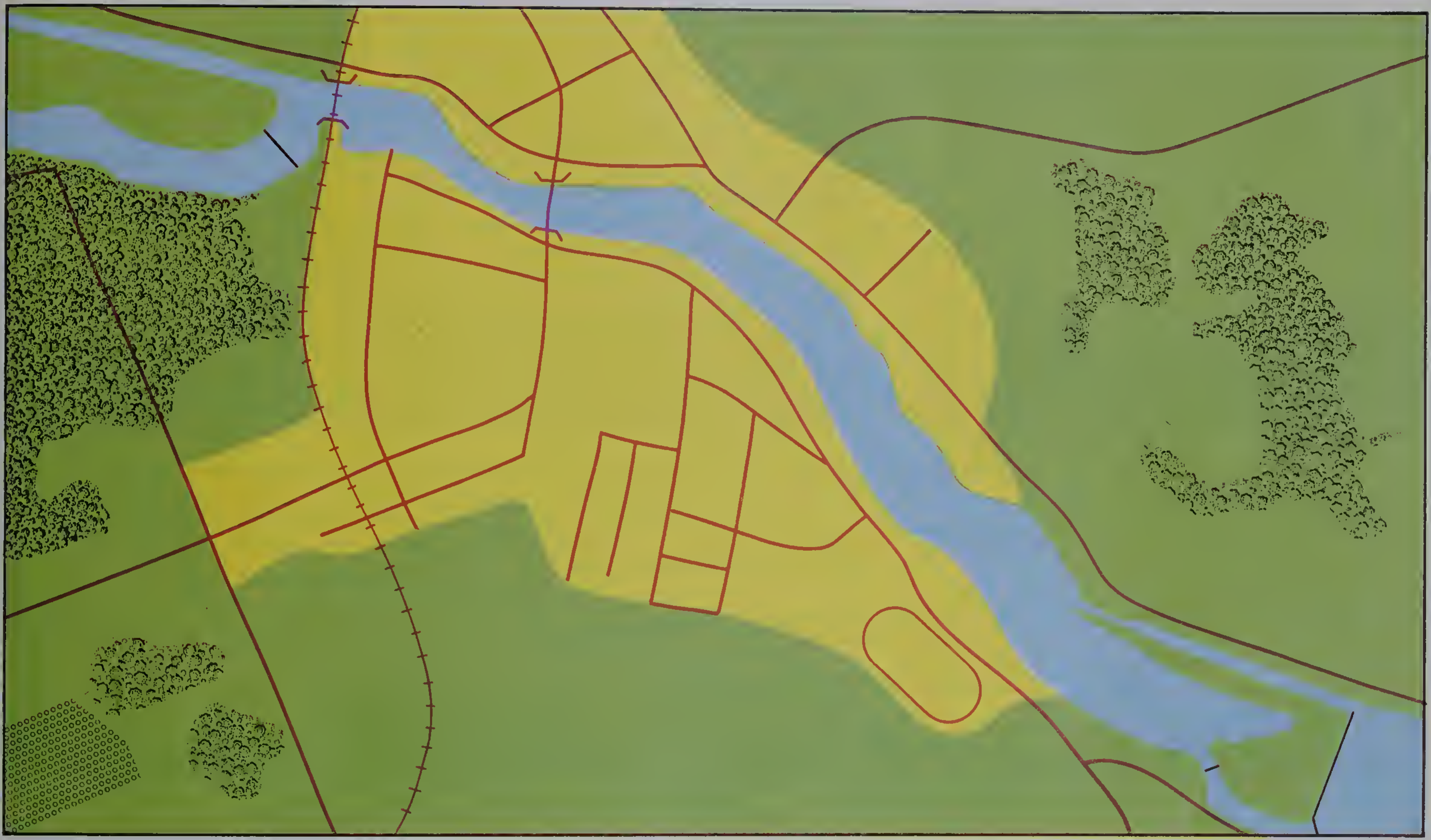
Try to pick out the river, the two bridges over the river, the railway track, the canal, and the dam. In which direction does the river flow?

Can you find farms, orchards, and woodlots? How can you tell the difference between a field and a wooded area? Try to find an orchard with the trees in rows.

What other objects can you identify? What is a landmark?

This aerial photograph can be used as a map because the camera was pointing straight down.





On a piece of paper, draw the shape or outline of five or six objects just as they appear in the photograph.

Each shape that you have drawn can be called a *symbol*. Symbols are used to stand for, or represent, objects. Now look at the picture of a map. How many symbols that you have drawn on your paper can you find on the map? How can you tell if the photograph and the map are of the same place? What can you see in the photograph that you cannot see on the map? What symbols would you use if you wanted to add these objects to your maps?

Digging Deeper

Why is the photograph called an aerial photograph?

In which direction are you looking when viewing the map?

Imagine that the photographer had pointed his camera at a different slant to the surface of the ground below. Would this aerial photograph be more like a map or more like a picture?

What does the word, perpendicular, mean? What words can you find in this activity that tell you that the photographer's camera was held so

A map drawn from the photograph on page 4 could look like this.

that it was perpendicular to the surface of the ground?

What details in the photograph shown are too small to be seen?

Would a car be a landmark?

What objects could be more easily identified in the map than in the picture. Why?

What things might be seen on a map that would not be seen from the window of an airplane?

Activity 3:

What are some types of maps?

If you thought that maps were mostly used by geographers and navigators, you may be surprised to find that geologists, historians, doctors, engineers, and many others use a large variety of special types of maps. Collect as many types of maps as you can by writing to, or visiting, some of the following sources.

Many gasoline stations will sell you road maps for 10 or 15 cents, or give them to you for free. Road maps can be obtained free of charge by writing to the Tourist Information Bureau of your provincial or state government.

Visit an architect's or civil engineer's office and ask politely for some blueprints that will no longer be needed. The school caretaker may allow you to examine the blueprints of the school building.

Examine various history books and try to find some maps drawn by early explorers. A librarian may be able to help you find books that contain old maps.

Topographical maps can be purchased from various governmental agencies. Perhaps you could borrow a topographical map from the geography department of a nearby high school.

Aerial photographs can be procured from the air photo libraries of your government. Try to obtain an aerial photograph of your area.

The library may be an excellent source of anatomy books that show maps of

Where could you obtain maps similar to these?

the structure of the human, or other animal bodies. Your family doctor may also be able to help you. Some encyclopedias have excellent maps showing the location of bones, nerves, blood vessels, and other body parts.

Your classroom will very likely contain one or more atlases. These books usually contain a wide variety of types of maps. Look at as many of these map collections as you can.

What other sources of maps can you find?

Complete a chart, similar to the one illustrated, to show how many of each type of map you collected or examined. Place a check mark in the appropriate column. If a map shows more than one set of information, you may have to use more than one check mark. Use the glossary at the back of the book to find the meaning of any terms that you do not understand. Total the number of check marks for each type of map when you are finished.

Digging Deeper

How many different types of maps did you discover?

Which was the most common type of map in your collection?

How many maps contained more than one set of information?

Which maps contained the most information?

For which map was it most difficult to decide what type of map it was? Why?

Which type of maps that you examined

Types of MAPS	NUMBER OF EACH EXAMINED	TOTAL	My Source of MAPS
Relief	✓ ✓ ✓ ✓	4	Holt's World Atlas
Route			Road Map
Resources			
Temperature			
Rainfall			
Minerals			
Population			
Soils			
Political			
Distances			

would you be most likely to use?

To whom might a relief type of map be most useful?

What type of map would be most similar to an aerial photograph?

Try to arrange the maps in order from the biggest to the smallest according to the size of the area they represent. Which were maps of small areas? Which ones represented very large areas?

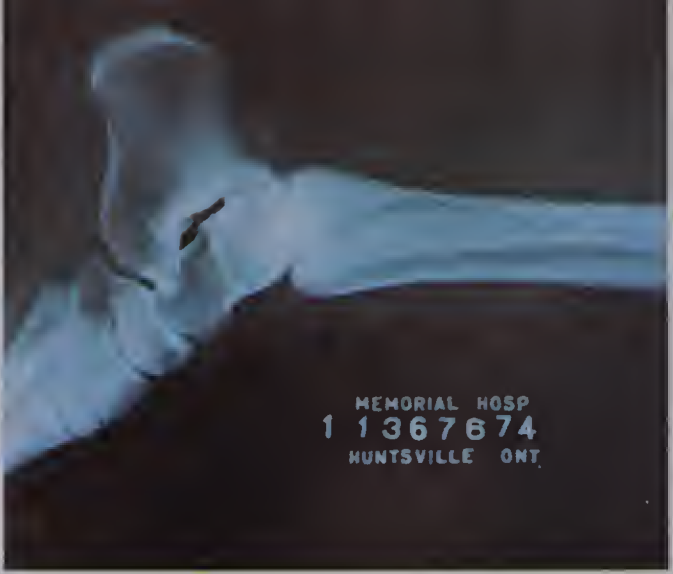
Which types showed two-dimensional representations of an area; that is, length and width only? Which types tried to show height or depth as well as length and width?

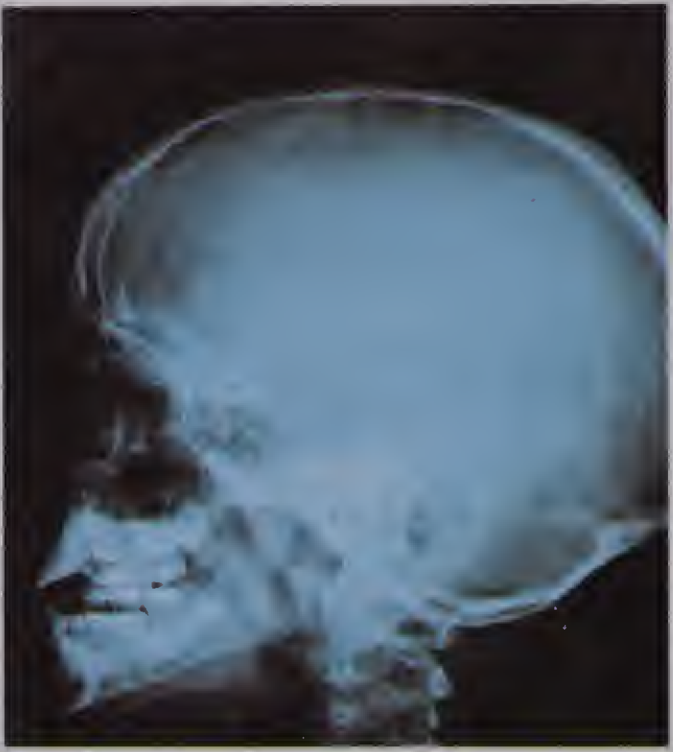
What are some of the things that must be taken into account before deciding what type a particular map is?

Branching Out

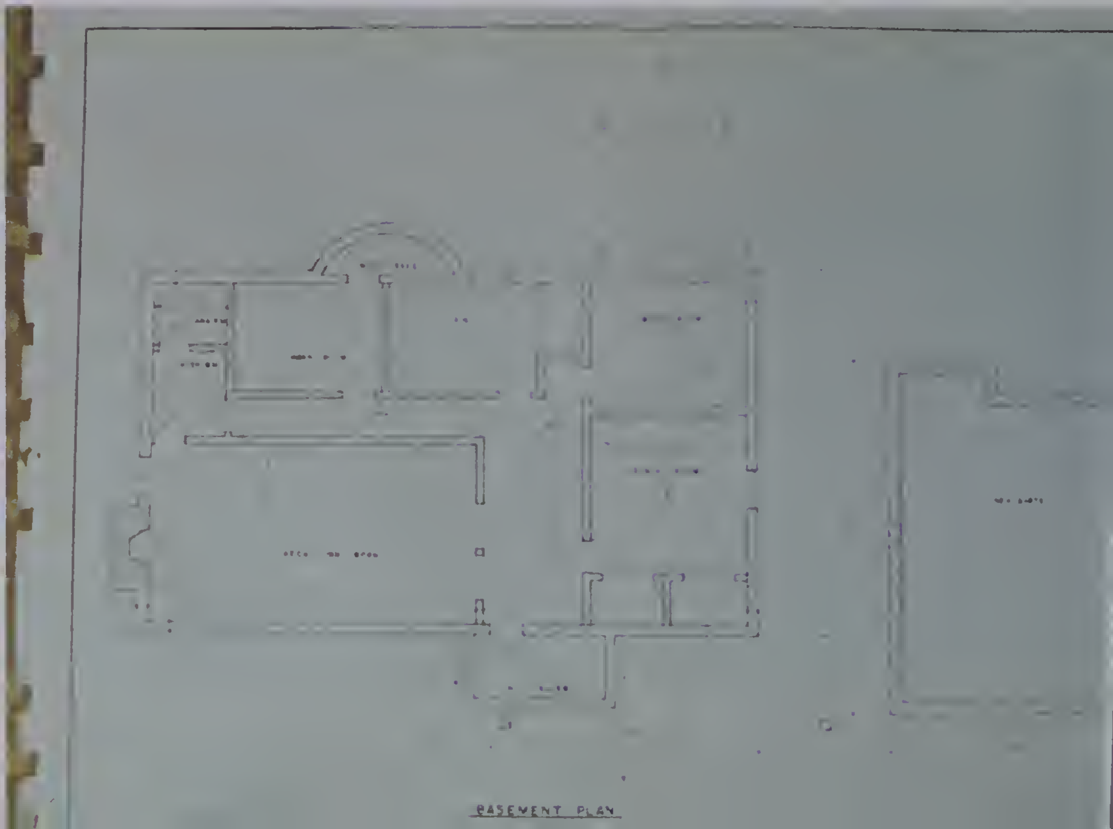
Obtain as many different maps as you can that include the area where you live. Count the number of different sets of details that each map showed about your area. These details might include streets or roads, sidewalks, houses, sewers, types of trees, hills and valleys, and so on. Which type of map showed the most details about your area? the least? How many types of maps would you need in order to compile twenty or more different sets of information about the area in which you live?

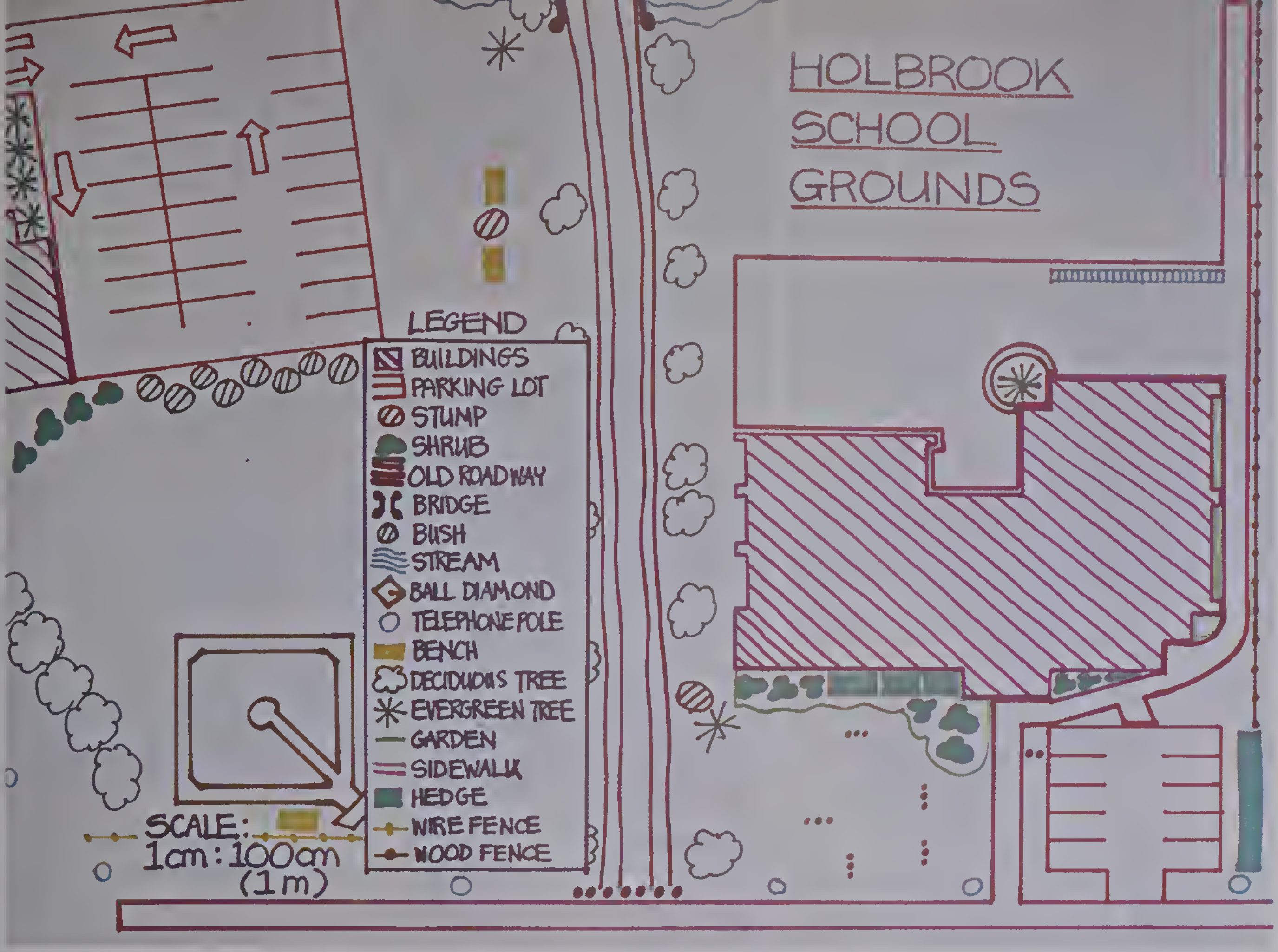
Which type of map would give the most information about a small area? Which of the maps you examined would be useful in giving information about your house and lot?





Here are two types of maps that are familiar to you. Give reasons to prove that these are maps.





Identify the map's features such as the legend, the title, and the symbols used.

Activity 4:

What are some important features of maps?

Study the map that a group of students made of a school building and its grounds. Try to list seven different features that you found on the map. All the symbols will count as just one feature. Check your list with the information about map features which follows, and try to answer the questions. You will need to use these features when you make your own maps.

Maps usually have *titles.* What words make up the title on this map. What information about the map does the title give you? What would be a good title for a map about the dandelions on a lawn?

Colors are used on maps. What color was used to represent the school building? What other color could have been used to represent the school building? What objects are the same color as the real things that they stand for?

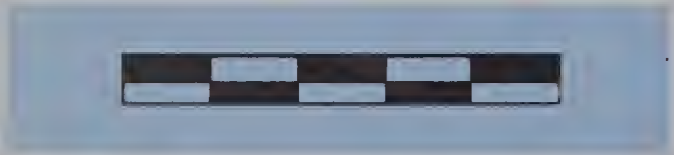
Many types of *symbols* are used on maps. Symbols may take the form of lines or shapes such as triangles, circles, and so on. Diagrams, letters, numbers, and even colors can be used as symbols. How many types of symbols can you find on the map shown? What shape was used to represent telephone poles? What kind of line could be used to stand for the edge of the school grounds where there is no fence?

A *legend,* like a key, is used to help you unlock the meaning of the symbols on a map. Map makers prefer to group examples of the symbols that they have chosen to use together, in one place, somewhere on the map where they will not be in the way of other information. This section of a map is called the legend. Each example placed in the legend has two parts. One part is the symbol; what is the other part? Why is a box sometimes placed around the legend?

Sometimes *words and numbers* are used directly on a map to name or give information about particular places or objects. These words and numbers are *labels*. What kind of objects were named by labels on this map? Why were the labels placed right on the object instead of in the legend?

Direction is indicated on a map by all or part of the face of a compass. This is called a *compass rose*. Suppose you wanted to use this map but you could not ask the students who made it any questions. How would you know which way to turn the map in order to make it match up with the area it represents? Which part of the compass rose points to the north? What do you think was used when the compass rose was being drawn onto the map in order to have the arrow part pointing to the north?

A map has one more important part called a *scale*. A scale is used to help you find distances on a map. Sometimes the scale is shown by a line like this,



or by words like these—*one centimetre to one kilometre*; or by numbers written in this way—1:100. The next activity will help you to understand how a map scale is used.

Branching Out

Look at the maps that you have collected in the previous activities and the parts of maps shown on the following pages. Use them to assist you in answering the following questions.

TITLES

How are the letters used in the title different from other letters used for other words on a map?

How often is the title located in a particular place such as at the top or bottom on a map?

How often is a title printed more than once on the same map?

How many of the maps that you examined did not have a title? If not, why not?

COLORS

What objects are usually the same color even though they appear on different maps?

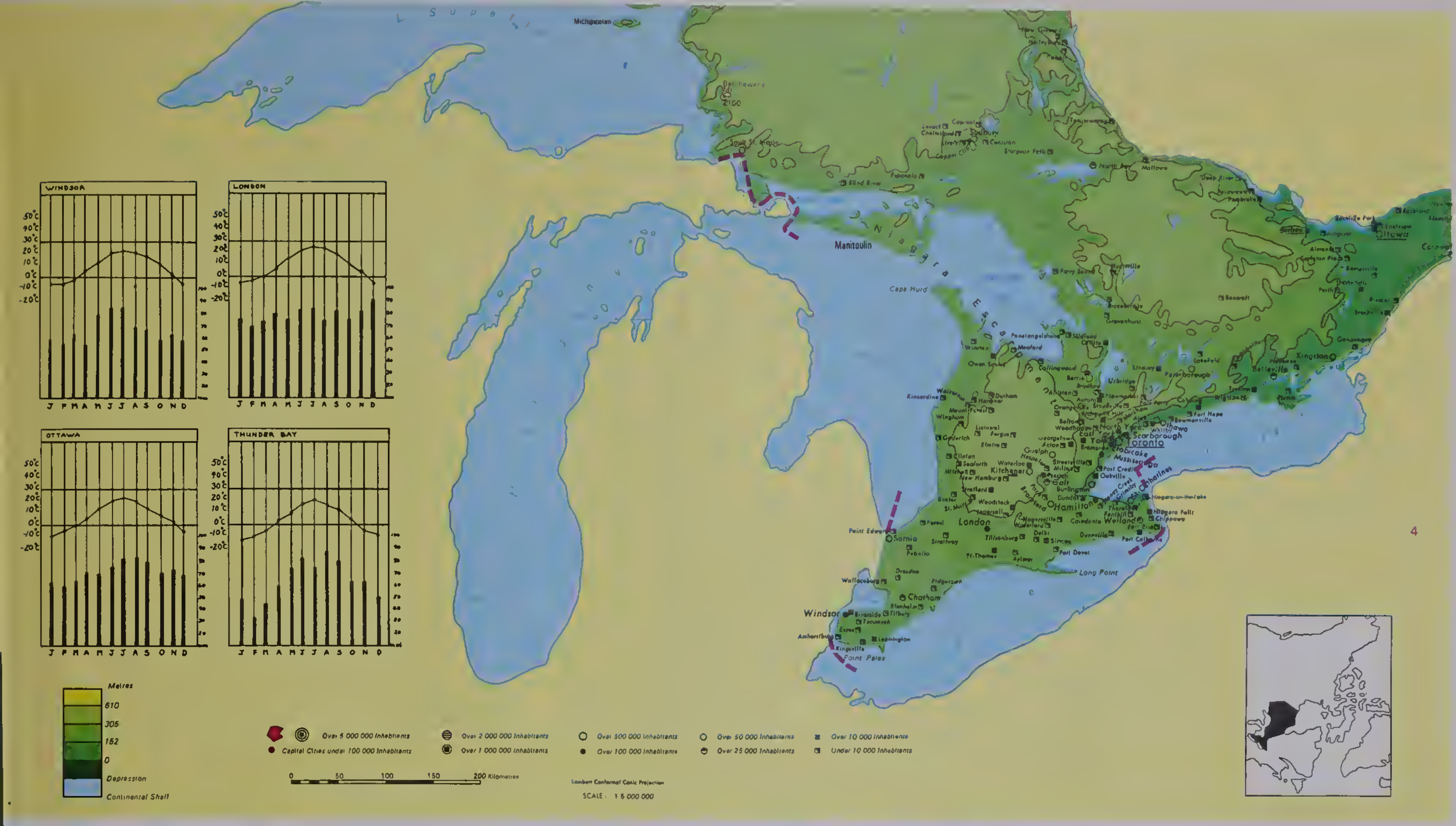
What things on the same map are the same color?

What color combinations show up best when placed side by side on a map?

What colors are usually used for the words that are placed on maps? Can you suggest a reason for this?

Which parts of maps often appear in very pale colors? Why? Where are the darker, more solid colors used? How can one color be used to show several sets of information on the same map?

What other methods than just the use of different colors can you find that show information on maps?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Niagara Escarpment
Cape Hurd
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North Bay
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Kingston
Belleville
Peterborough
Toronto
Scarborough
Mississauga
Hamilton
Kitchener
Waterloo
Guelph
Galt
St. Catharines
Niagara Falls
Welland
London
Sarnia
Point Edward
Chatham
Windsor
Amherstburg
Kingsville
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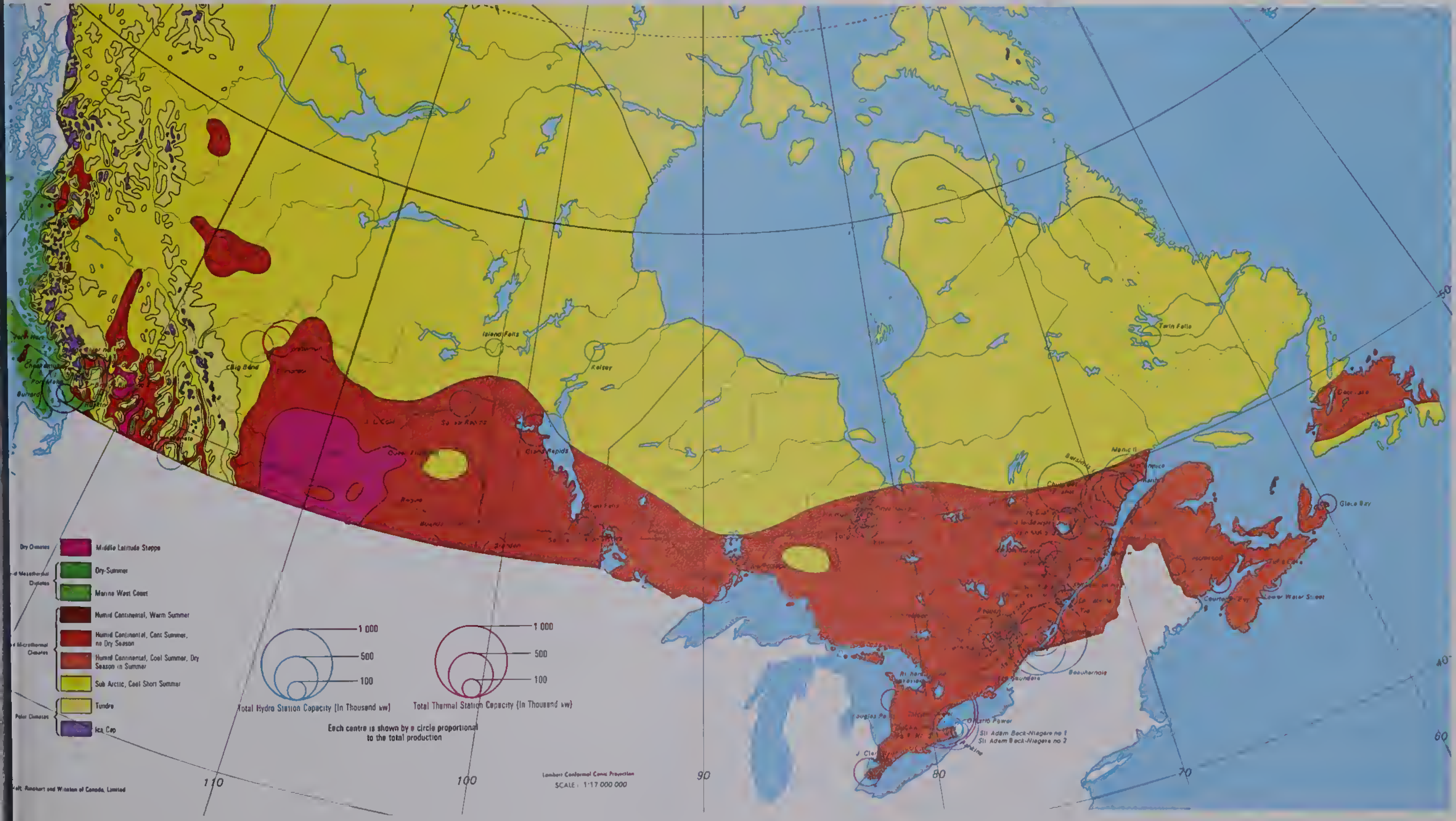
Island Falls
Kelsey
Grand Rapids
Twin Falls
Glace Bay
Sir Adam Beck-Niagara no 1
Sir Adam Beck-Niagara no 2
Dry Climates
Middle Latitude Steppe
Mesothermal Climates
Dry-Summer
Marine West Coast
Microthermal Climates
Humid Continental, Warm Summer
Humid Continental, Cool Summer, no Dry Season
Humid Continental, Cool Summer, Dry Season in Summer
Sub Arctic, Cool Short Summer
Polar Climates
Tundra
Ice Cap
1 000
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Total Hydro Station Capacity (In Thousand kW)
Total Thermal Station Capacity (In Thousand kW)
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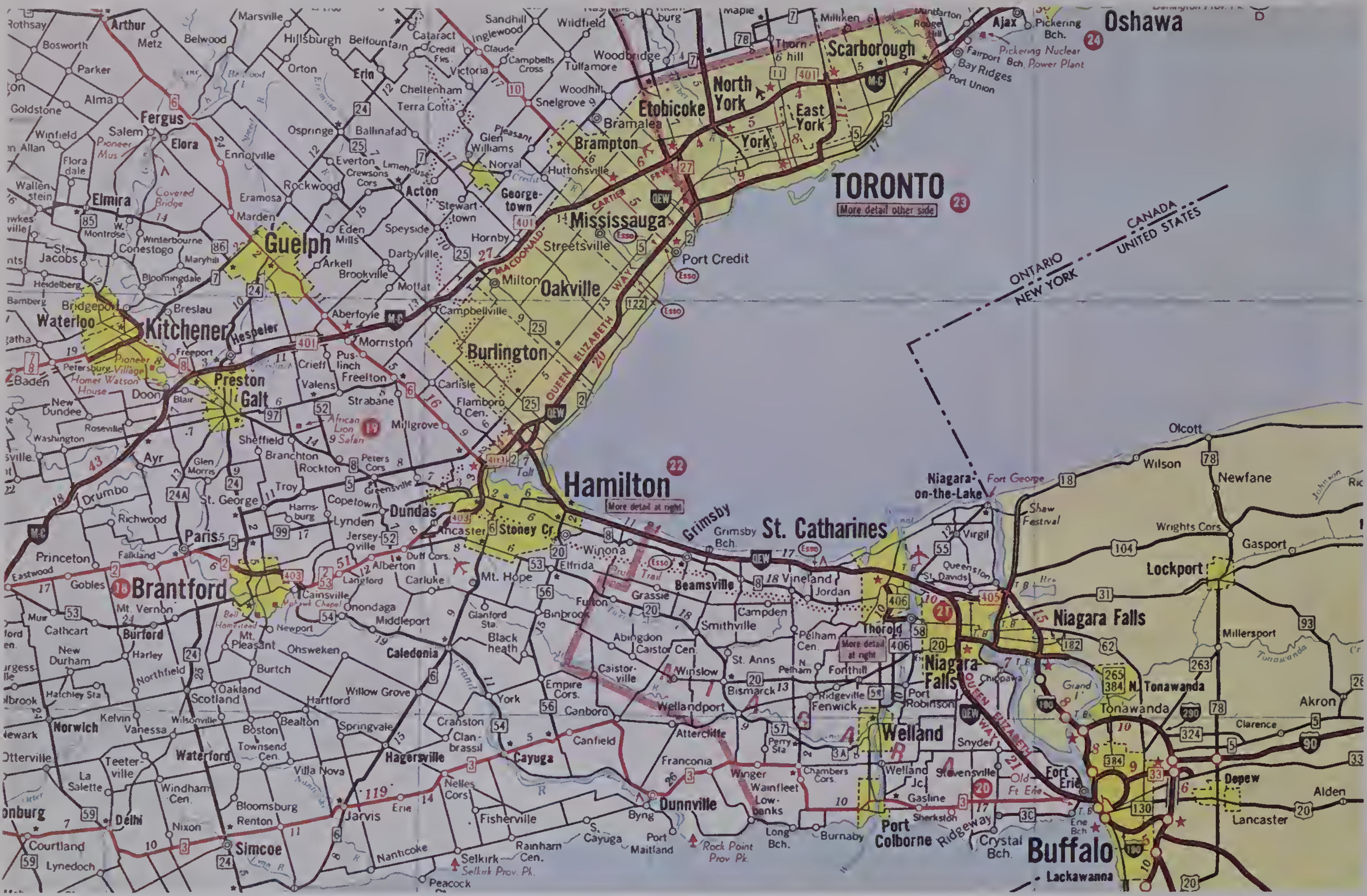


LINES

Study the road map.

How can you tell which symbols are roadways and which are rivers?

How are boundary lines different from roadways?

How many different types of roadways can you find, for example, roads, highways, or freeways? How is each type of roadway marked? What type of symbol is used to represent most of the roadways? What type of roadway may have more than one symbol to represent it? Do the symbols used for roads show all the detail that you would see if you examined a real road? Why?

In what different ways on other types of maps have lines been used for symbols?

SHAPES

Locate several cities, towns, and villages on the road map. Make a list of all the symbols you can find that were used to represent municipalities.

Which shape is most like the real shape of the actual city or town it stands for?

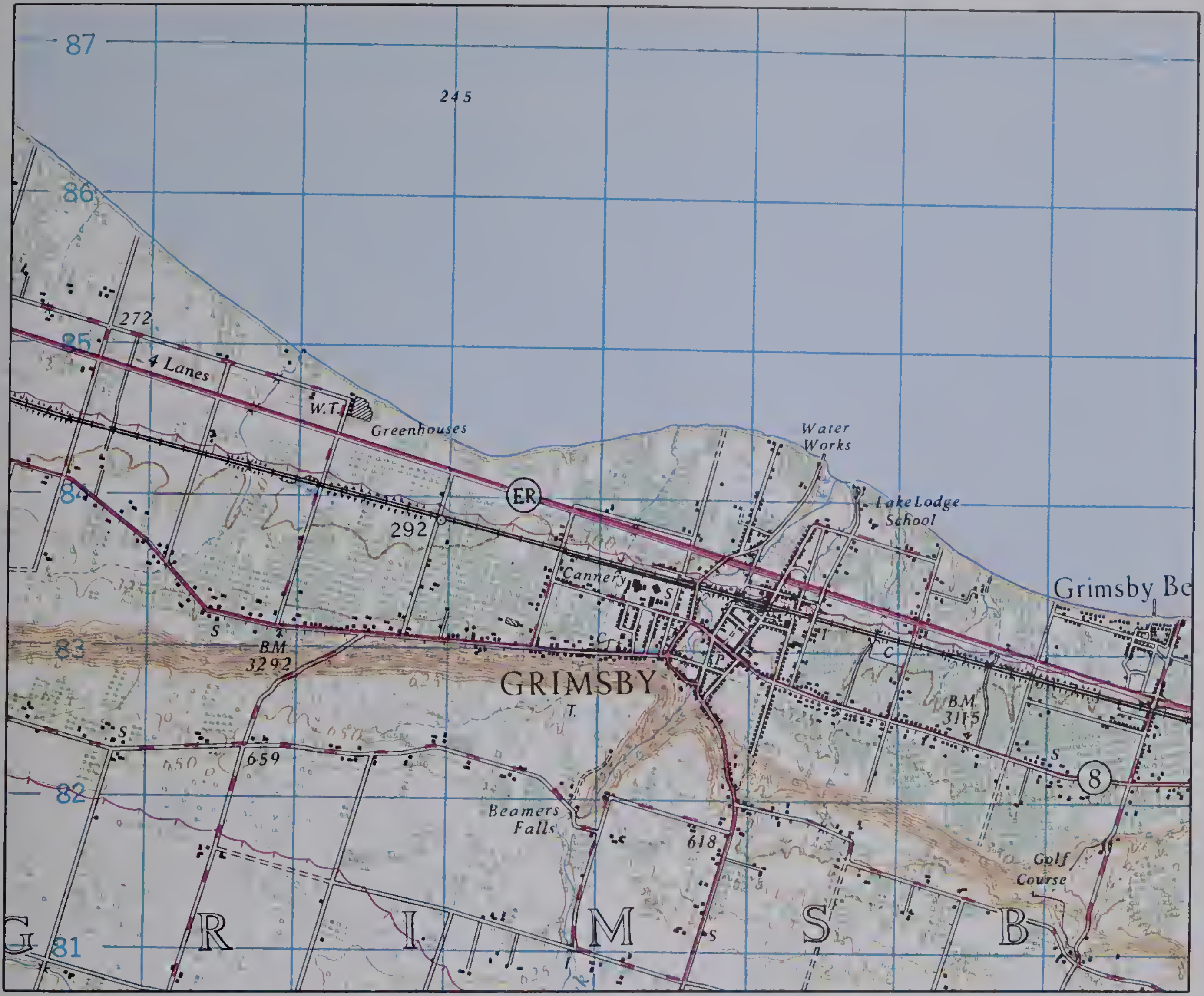
Why were symbols, instead of diagrams, used to represent towns and villages?

How can you tell large cities from smaller ones by looking at a road map?

How are the main streets inside a large city shown on a map of a very large part of the country?

Look at some other maps. How are capital cities shown to be different from the other cities. Is the same system that

On this page is part of a road map; at the top of page 13 is part of a topographical map.



was used to represent types of cities and towns on the road map used in other types of maps?

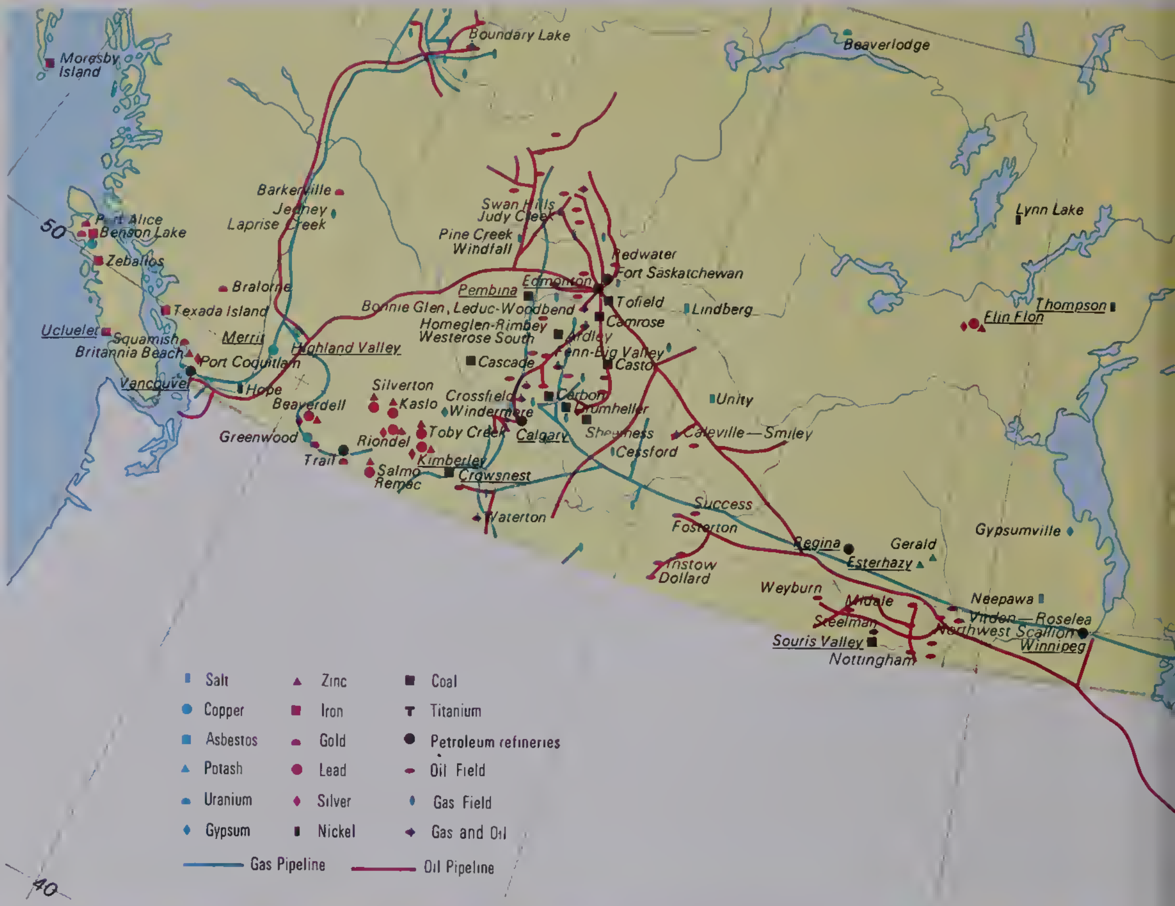
What other shapes such as triangles, squares, or crosses, can you find on the maps? What do these shapes represent?

DIAGRAMS

A diagram is an outline of an object. Sometimes diagrams are used to show the location of things. For example, a pine tree shows where camping or recreation areas are to be found. What would an airplane indicate?

What other diagrams can you find on the road map? What do these diagrams symbolize?

Some map legends. Can you use them?



NUMBERS AND LETTERS

Find several letters and numbers on the road map. What does each tell or represent?

Why are symbols used in place of pictures? Which type of map contains the most symbols? the least?

What is the connection between the size of the area shown in the map and the number of symbols used?

What are some examples where more than one symbol has been used to represent the same type of object?

LEGENDS

What information, other than just the labels and their symbols, may be included in the legend?

Which is usually placed first, the symbol or its label? Which arrangement do you prefer? Can numbers be used as labels in the legend?

What types of maps may not have legends? Why?

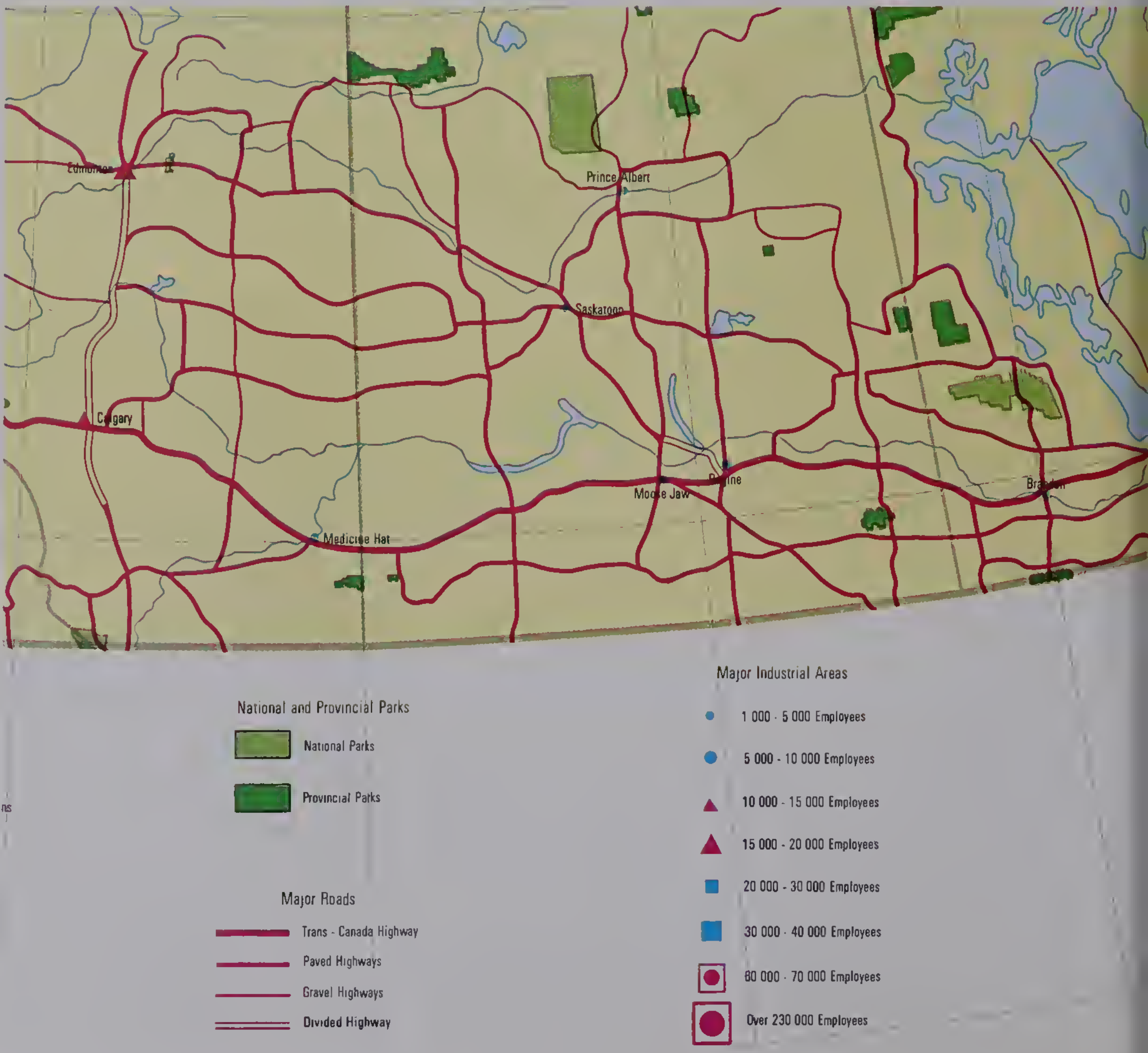
Where might be some other good locations to place the legends on the maps that you examined?

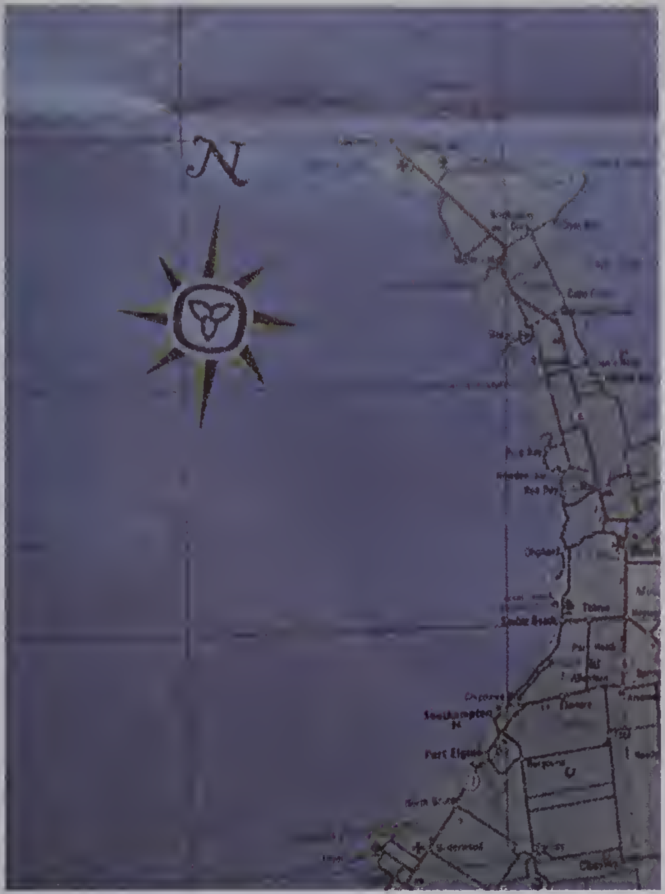
LABELS

List the names of several cities, rivers, lakes, or countries that are labelled on your maps.

How is the type of lettering used to label cities different from that used to label bodies of water?

How are larger objects labelled differently from smaller objects of the same type?





What does this compass rose indicate?

What other methods of labelling, in addition to words, might be placed on maps?

COMPASS ROSES

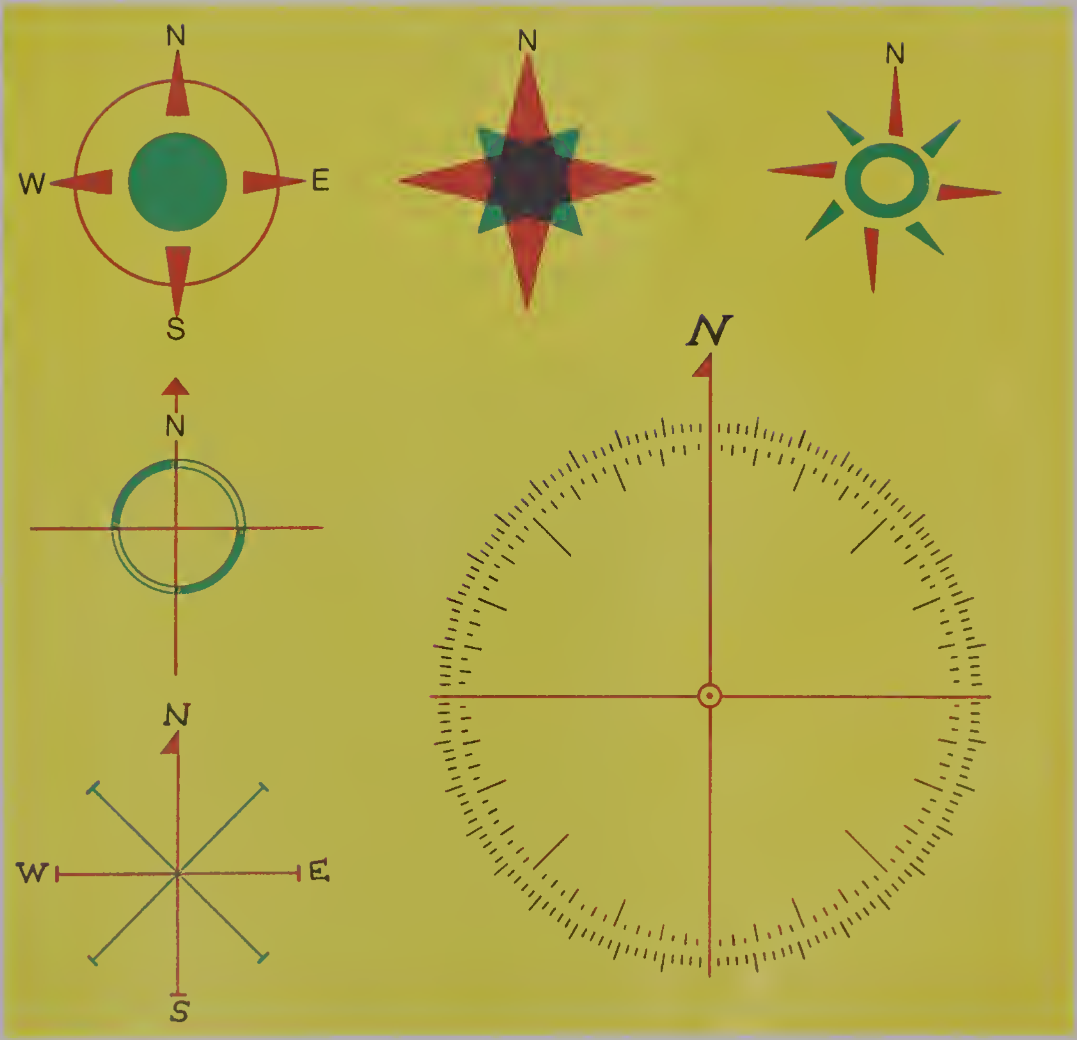
Map makers have agreed that, unless they indicate otherwise, the top of the map will face toward the north. If it is impossible for some reason to make your maps so that the top will be north, then some other method of showing the direction of north will be needed. Examine the maps in your collection to see if you can find diagrams of compass roses similar to the ones illustrated.

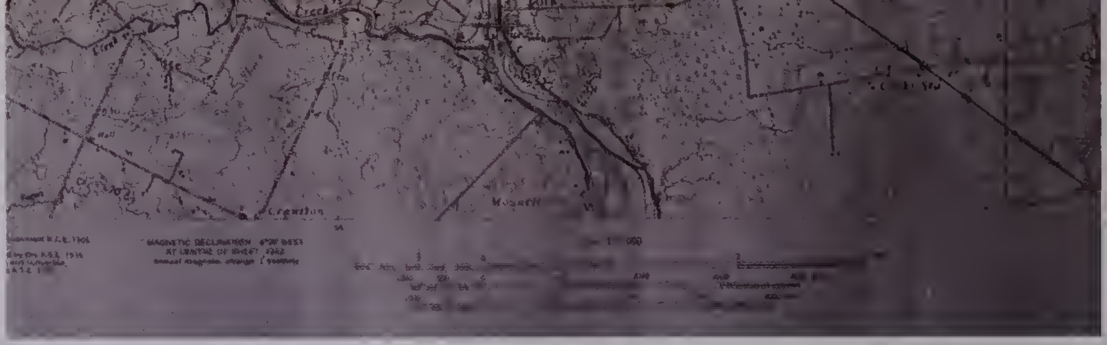
Which compass roses are very simple? Which are fancy? Which one is your favorite compass rose? Why?

What letter is found on almost every compass rose?

What will be needed in order to turn the map so that the arrow of the compass rose will point in the correct direction?

Moving the map so that it is facing in the right direction is called orienting the map. What other methods or information could be used to orient a map besides using a compass?





Activity 5:

How is the real size of objects shown on maps?

In Activity 2 you saw that a map was a bird's-eye view of an area perpendicular to its surface. The size of the area had been shrunk so that it would fit onto a page of this book. How could someone use the map in order to find the true length of one of the bridges shown on that map? The scale on a map is there to help solve this problem.

Measure the length of scale line A from the point marked *0* to the point marked 1 km.

How many cm on your ruler were needed to make 1 km on the scale line? If this scale line belonged on a map, how many cm would represent 1 km on that map?

Now measure the length of scale line B from 0 to 1 km.

How many cm did it take to make 1 km? How many cm would it take to make 1 km on the map to which this scale line belonged?

Finally, examine scale line C.

How many cm to 1 km does this scale indicate?

Sometimes just the words are used instead of the scale line. For example, scale line A tells you that there are ''10 cm to 1 km''. This is called the *direct statement of scale*. The direct statement of scale for scale B is ''5 cm to 1 km. How would you word the direct statement of scale for scale C?

One way that the direct statement of scale should not be written is 1 cm *equals* 1 km because 100 000 cm = 1 km.

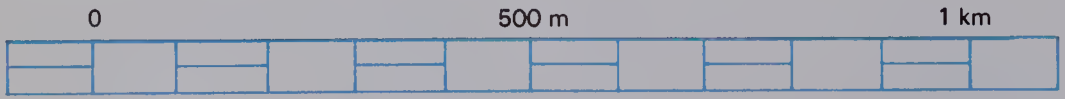
Digging Deeper

Using scale line A, how many km would be represented by 20 cm? by 5 cm?

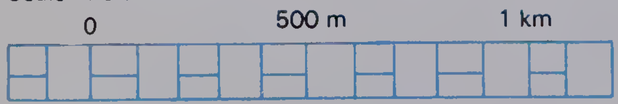
Using scale line B, how many km would be represented by 10 cm? by 2.5 cm?

If you measured the distance between two roads on a map with a ruler and found the distance to be 10 cm and if you used scale line A, you would know that the real distance between the roads was 1 km. How far apart would the roads be if you used scale line B, or scale line C?

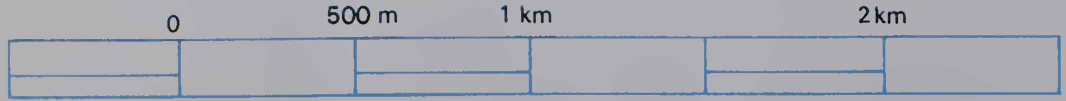
Why is more than one scale line shown on this map?



Scale line A



Scale line B



Scale line C

What steps are being taken to find the real distance between two points on the map?

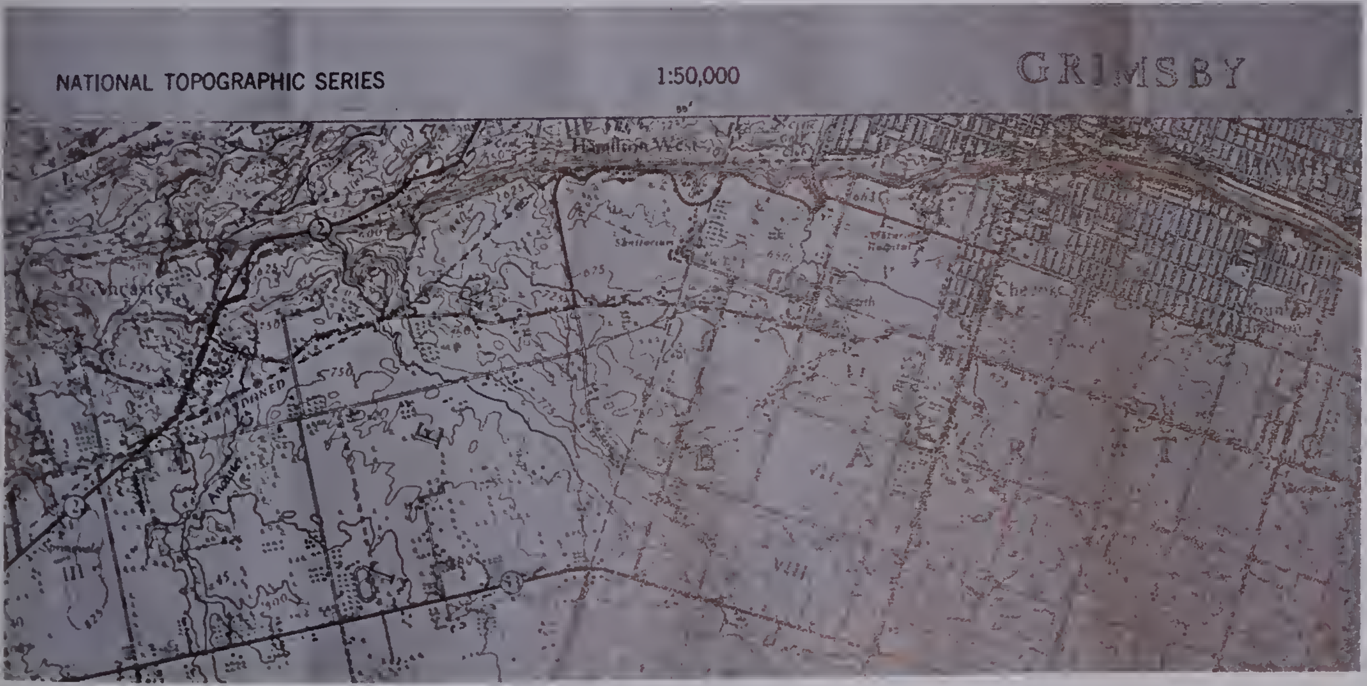
Branching Out

Use a ruler and the scale line on a map to find the real distance between various points that interest you. Ask an adult to check your accuracy.

How could distance be measured along a curving or wriggly line such as a river? How long is the longest river on your maps?

A third method sometimes used to indicate size or distance on a map is called the rational ratio (sometimes *representative fraction*) or *R.R.* The rational ratio, 1/500, means that one unit of measurement on the map represents 500 of the same units measured on the ground. The R.R. is usually written like this—1:500. It does not tell us whether the units are centimetres, metres, or kilometres. What would be the meaning of the R.R. 1:500?

What is a cadastral map? Who would be the most likely to use one?



Use the representative fraction shown on this map to find the real distance between two roads.

OLD MAPS

What would be the importance of knowing when a map was made or who made it?

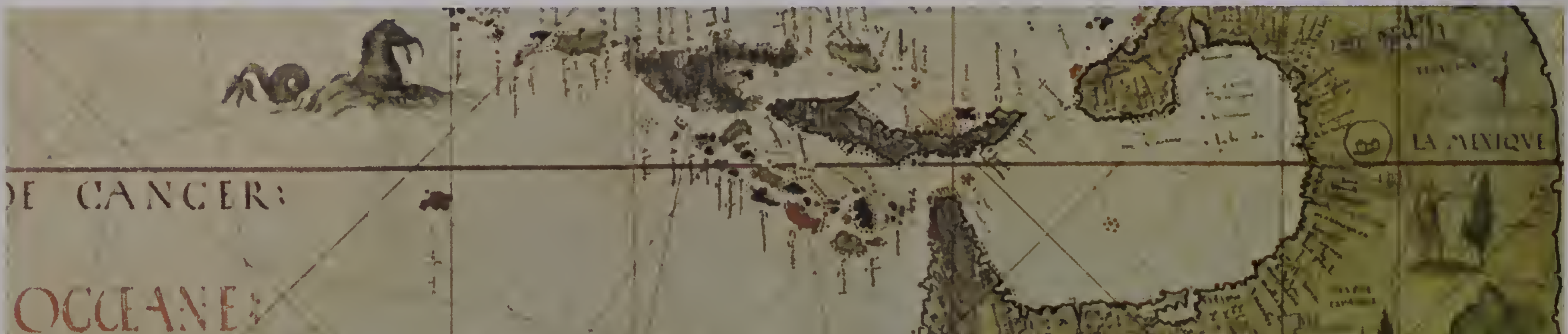
Which map in your collection is the oldest? In what ways is it different from the more modern maps? Why is an old map usually believed to be less accurate than a newer one? What would be needed before an old map could be improved?

Try to find pictures and descriptions of the methods and tools early explorers used to make their maps. What problems were the early map makers trying to overcome by making maps?

Look at the old map shown in the picture. Try to recognize what part of North America it represents. Turn it upside down. Which way was it drawn? In what century was this map made?

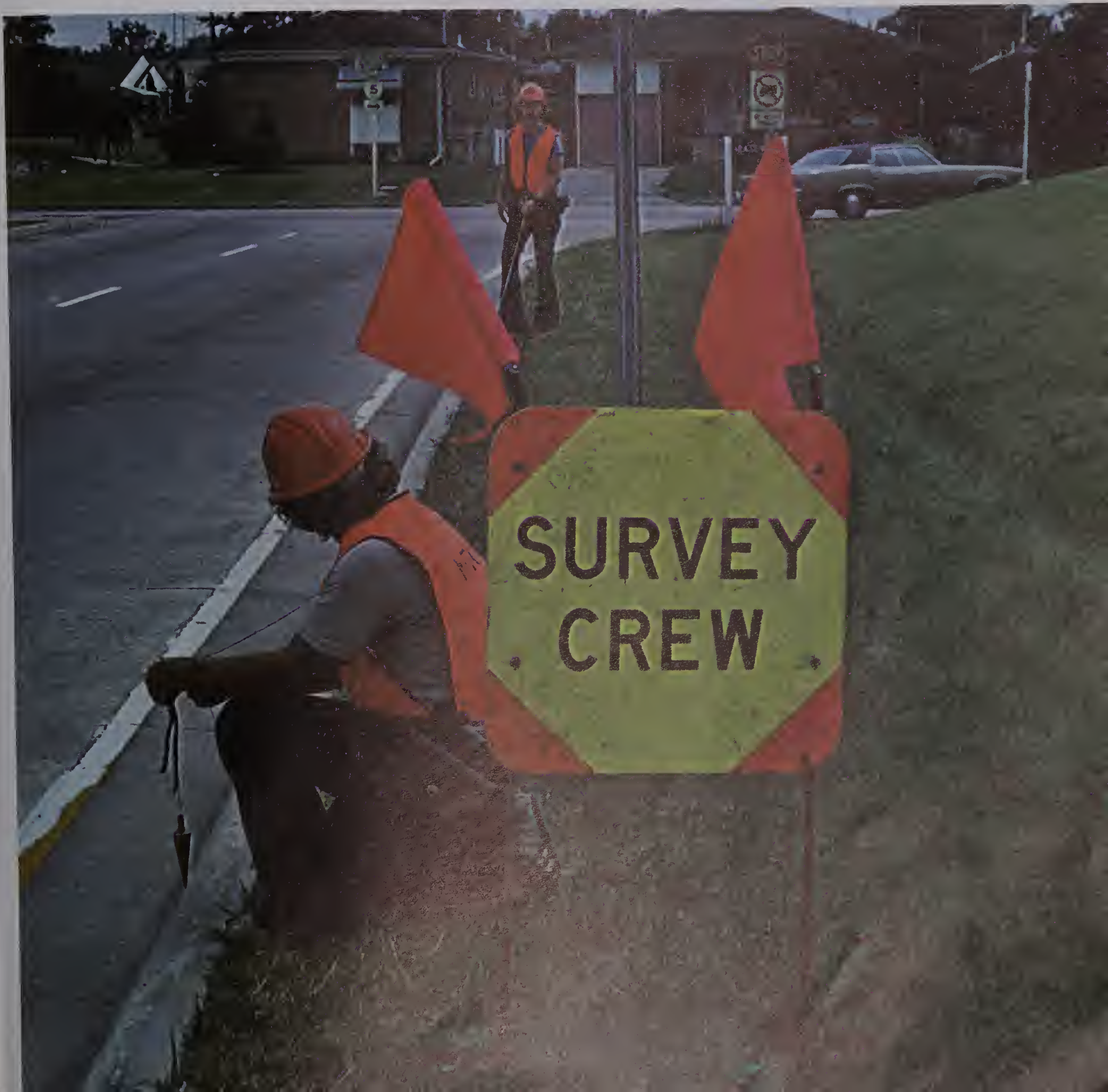
Look up the word *standardize* in a dictionary. How does this term apply to the needs of map makers working at the time that the old map of North America was made?

What part of the world does this old map represent?



Over And Across

2



2. Over And Across

Now it is time for you to start to make your own maps. At first, your maps will be very simple ones of small areas. A good place to begin is in your classroom. However, before you can draw your map, you will need to collect some information or data. A person who collects data in order to make maps is often called a *surveyor*. You will need to learn how to *survey* an area before you can make accurate maps of it.

Activity 1:

How can you locate objects, such as the furniture in a room?

Imagine that it is necessary to paint the floor of a room. The furniture must be taken out of the room, and then put back again exactly where it was. You could not put marks on the floor because these would be covered by the paint. What other methods could be used? How would you go about gathering the information that would be required? Surveyors would use a process called the *base line and offset method*. You have already used a method very similar to this if you have made a graph or used a grid of squares to enlarge a drawing.

The next activities will aid you in collecting accurate data for making a floor plan map using the base line and offset method.

Activity 1(a):

How can a suitable base line be selected?

Select a long line on the floor from which you could measure across to the furniture in the room.

Consider the following questions in making your choice.

Will the line still be there after the floor is painted or the furnishings are moved?

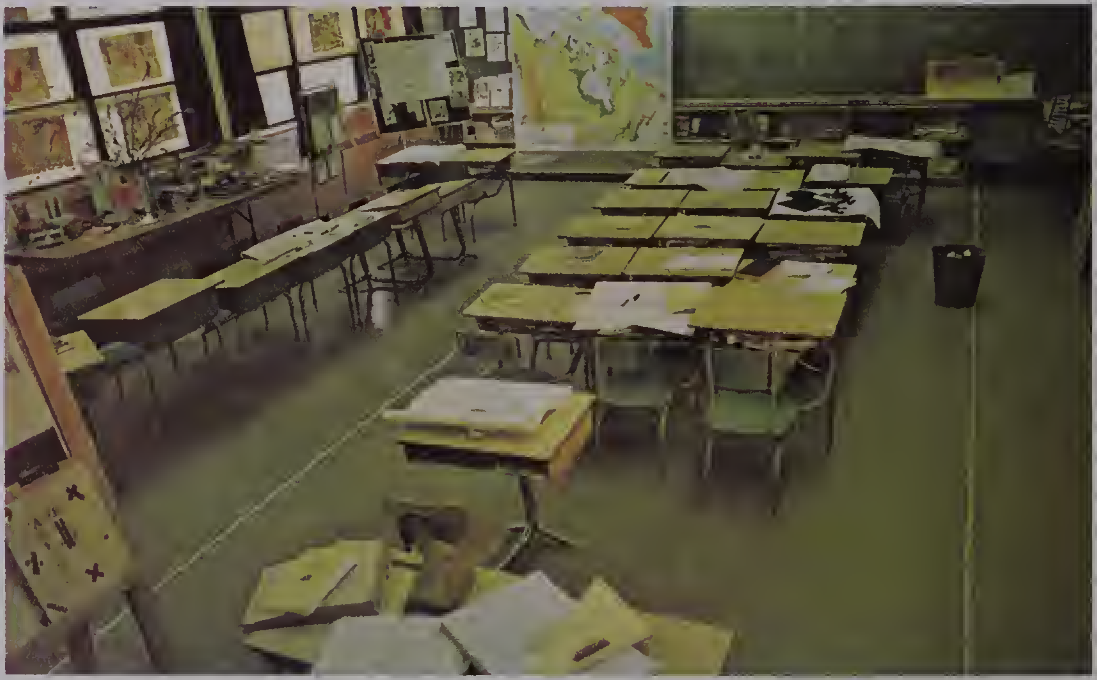
Is the line perfectly straight?

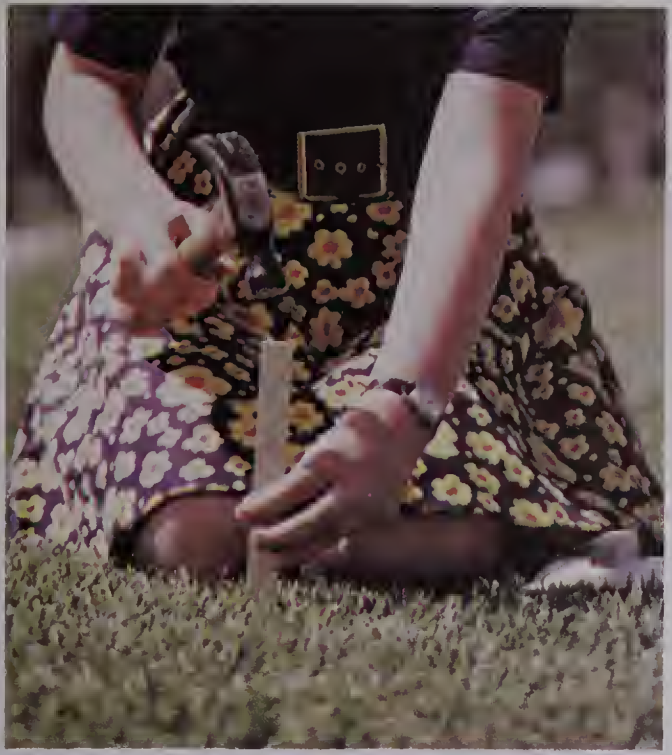
Could you find the same line easily again later on?

Is the line easy to get at and work along?

This line is called a *base line*. Some good base lines in the room might be the moulding where a wall meets the floor, or the crack running between two rows of boards or tiles. The choice of a suitable base line is very important because all other measurements will be made along it or outward from it.

Are these base lines suitable for mapping this classroom?





Digging Deeper

What parts of the room other than those mentioned could be used for base lines?

How could a string be used as a base line? In what other ways could you make base lines?

Could the base line be located
(a) along any side of the room?
(b) down the middle of the room?
(c) from corner to corner in the room?
Where would you locate the base line in a round room?

How long should a base line be?

Branching Out

When cracks, walls, or other parts of the room are used as a base line, then it can be called a *natural* base line. When a tape or rope is used to form your base line, this type is called an *artificial* base line. In making a map of your front yard, what are some natural base lines that could be used? Where in your front yard could you locate artificial base lines? What would you use to make them?

Activity 1(b):

How can the base line be divided into appropriate units?

Start by choosing a suitable starting point on the base line. The following questions will guide you in selecting a good starting point.

Is the starting point close to the end of the base line?

Is the starting point well marked so that you can easily find it again?

Beginning at the starting point, divide and mark off the base line into equal parts. Each part will be one *unit*. Are there some natural units that you could use such as the cracks between the tiles? If not, you might consider the length of your shoe, your ruler, or perhaps a book. You could use metric units of length such as millimetres, centimetres or metres.

Digging Deeper

Does the size of the unit fit the job that it must do? Why would centimetres and metres but not kilometres, be good units to use inside a room?

When using a rope as an artificial base line tying each end to a stake driven into the ground may be helpful.

How many base lines do you see in this photograph?

Into which units is this base line being divided?

Can the unit be easily used again later? That is, do you have, or can you make a ruler that is divided into your units?

Can the unit that you selected be easily divided into smaller parts? Can it be easily combined into larger units?

At which end of the base line should the starting point be located? Why might it be unwise to locate a starting point in the middle of a base line?

When would the use of large units be better than smaller ones? What other things, in addition to size, should be taken into consideration when selecting a unit?

If the units were to be numbered along the base line, what would the number of the starting point be? How could a ruler be used to locate the position of half or a quarter of a unit on the base line? If several people are going to work on the same map, what decision about units should be made?

Activity 1(c): How can the offset distances be calculated?

Measure the distance from the base line to each object.

Before you make these measurements, try the following.

Obtain three pieces of string, long enough to reach from a chair or table leg and pass over the base line. Tie the strings to the leg and close to the floor. Stretch one string tightly so that it will cross the base line at the starting point that you have already marked. Stretch the second string so that it crosses the base line at the unit mark closest to the leg. Stretch the third string so that it crosses the base line near the far end of the base line.

Cut off each string where it crosses the base line and compare the lengths of the pieces tied to the leg.

Which string comes the closest to being the shortest distance from the base line to the chair or table leg?

Tie the longest of the three strings to the leg as close to the floor as you can. Extend this string until it crosses the base line and is tight enough to form a straight line. Move the string forward and back along the base line until it makes the shortest distance from the base line to the chair leg. This distance is called the *offset.*

Which string most closely represents the offset distance?

Carefully fit the square corner of a book cover, floor tile, or piece of cardboard into the corner made by the base line and the offset string.

How could the number of units in the offset distance be found?

Note: In map making, it is very important that the same units be used for the offset as are used for the base line.

Use the string and square corner to find the offset distance to another leg on another chair, table, or desk. Practice measuring some other offset distances.

These students are using a square corner to measure the offset distance from the base line to the leg of the desk.

Digging Deeper

Why should the string used to measure the offset be kept tight?

What could occur if the offset string was pulled too hard?

Into what units should the offset string be marked?

Where would the starting point be for dividing an offset string into units? Why should the same units be used for the offset as were used for the base line?

If the tiles on the floor were being used as units, what could be used in place of an offset string?

Why would a long tape measure make a good offset string?

In addition to a base line and offset string, what else must be used whenever an offset distance is being measured?

What type of corner is formed by a right angle, or an angle of 90 degrees?

How many measurements would be needed to accurately locate on your map, a chair with four legs?

To what part of a round object, such as a drain pipe, would you measure the offset? What other information would be needed before you could accurately draw a round object on a map?

If the edge of a table extends out over the place where the legs touch the floor, to what part of the table would you measure the offset?

Is it better to measure the offset starting from the base line and counting toward the object, or to go in the opposite direction?

How could you use the base line and offset method to accurately locate the walls of the room?

Why is it a good idea to work with other people when using the base line and offset method?

Branching Out

Ask the school caretaker, your father, or a hardware store clerk, to show you the types of tools a builder would use to test to see if a corner is square. What are the names given to these tools? Which one would be most useful to you in measuring offset distances?

What object in the room can you find that has the most square corners on it?

Activity 1(d):

How can the data you collect be recorded?

Make a chart or a diagram on which you can record the measurements you made so that you will be able to remember them and use them later. If you made a chart, it might look similar to the one shown.

Digging Deeper

What unit was being used in the chart? Was this a good unit? Why? What was the distance calculated if the object was part way between two units?

Branching Out

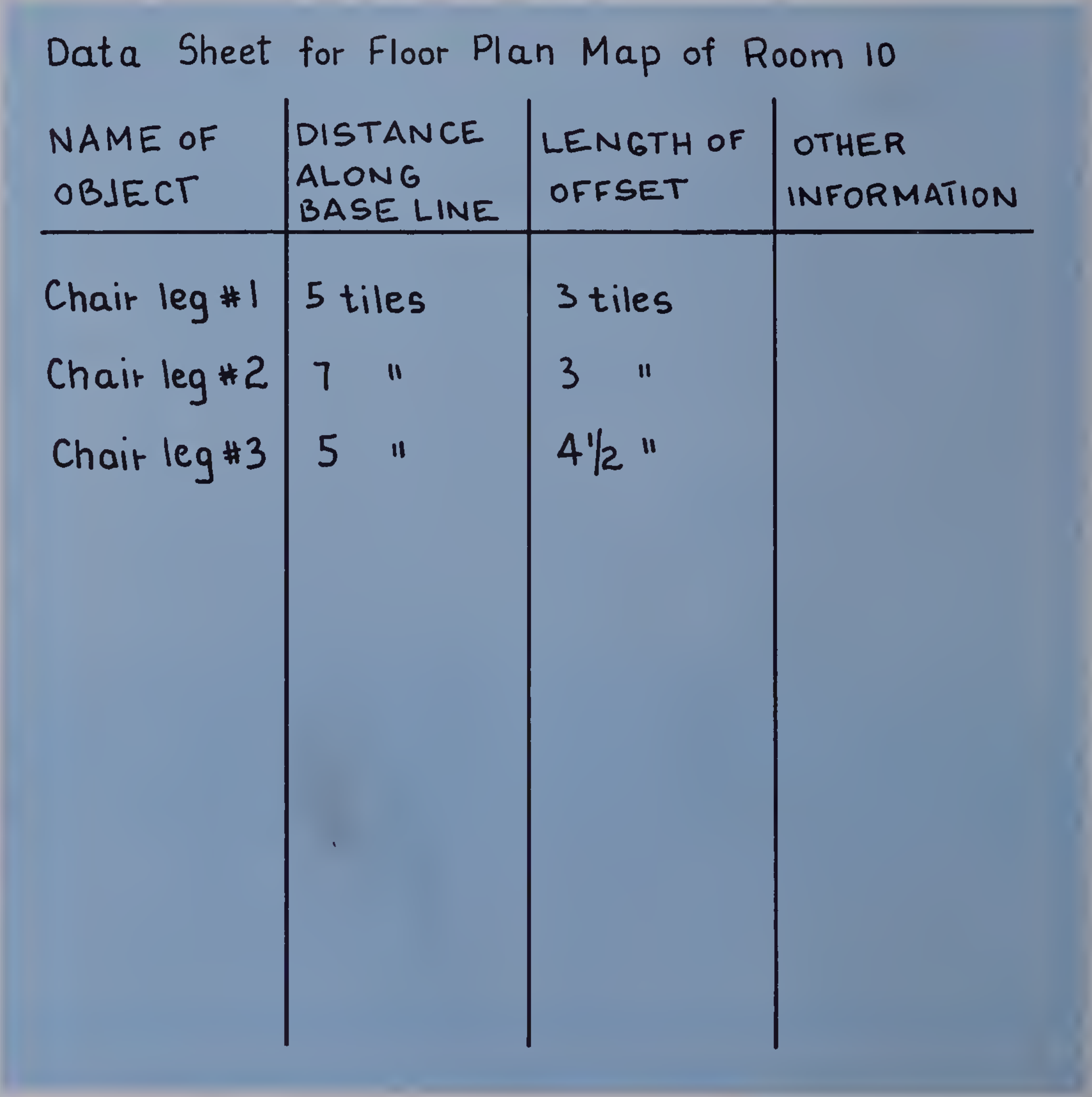
Select a piece of furniture whose location you have recorded in your chart. Move the piece of furniture and then ask another student to use your chart to try to put the furniture back exactly where it was. How can you be sure a location is correct without putting marks on the floor?

Discover a historical building or fort that has been rebuilt or moved to a new location. Try to find out the methods used to reconstruct the structure precisely as it was long ago.

How would a museum go about mapping a room in order to build a model of it?

Make a map of your backyard. Place a message in a jar and bury it. Carefully rearrange the earth or grass so that no traces of this spot can be seen. Accurately locate the place where the jar was buried on your map. Give your map to a friend and ask him to use it in order to locate the buried message.

How could the base line and offset method be used to map the objects in each of the scenes on the next page?



Data Sheet for Floor Plan Map of Room 10

NAME OF OBJECT	DISTANCE ALONG BASE LINE	LENGTH OF OFFSET	OTHER INFORMATION
Chair leg #1	5 tiles	3 tiles	
Chair leg #2	7 "	3 "	
Chair leg #3	5 "	4½ "	

SIGNS O

Activity 2:

How can you make a measuring line?

In many of the activities that follow, you will need a device for measuring distances up to 30 m in length. If you do not have a 25 m or a 50 m tape measure, you should make a measuring line similar to the one shown in the plans.

Obtain a long piece of butcher's string, clothesline, or sash cord. Use a metre stick or a tape to mark the measuring string into 25 cm units. Use dabs of house paint or pieces of colored tape to mark the units. Perhaps every 25 cm length could be marked in a different color.

Make a holder on which to wind the measuring string when it is not in use.

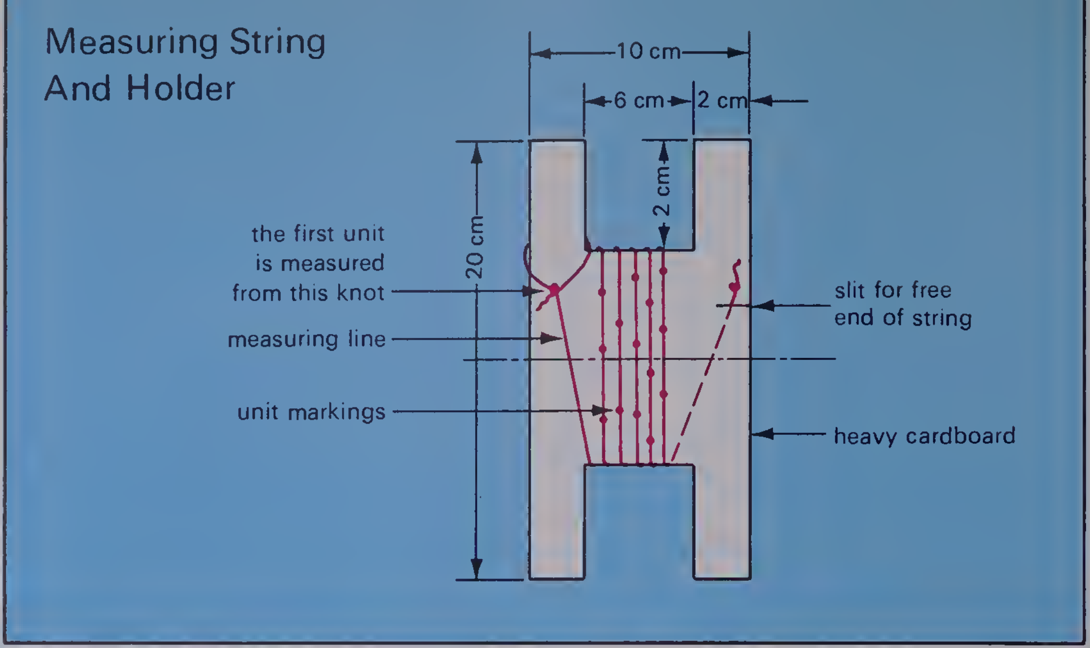
Digging Deeper

Why would wool or binder twine make a poor measuring string? Why would chalk or ink be poorly suited for use in marking of the units? Why would metres and centimetres be good units to use?

Why should the measuring string be pulled tightly several times before marking off the units?

What effect might wetting the string have on the size of the units?

What would be the very best material from which a measuring cord could be made?


Measuring String And Holder
10 cm
6 cm
2 cm
2 cm
20 cm
the first unit is measured from this knot
measuring line
unit markings
slit for free end of string
heavy cardboard

Why is this a good method for storing a measuring string?

Two colors are being used to divide this measuring string into units. Why?

Activity 3:

How can you draw a floor plan map of a room?

Use the base line and offset method to find the locations of the furniture and other parts of the room that you wish to include in your map. Record this information in a chart similar to the one shown on page 24.

Obtain as large a piece of graph paper as you can. For your first attempts graph paper with centimetre squares would be best. Use a pencil and ruler to draw your map. Follow these steps.

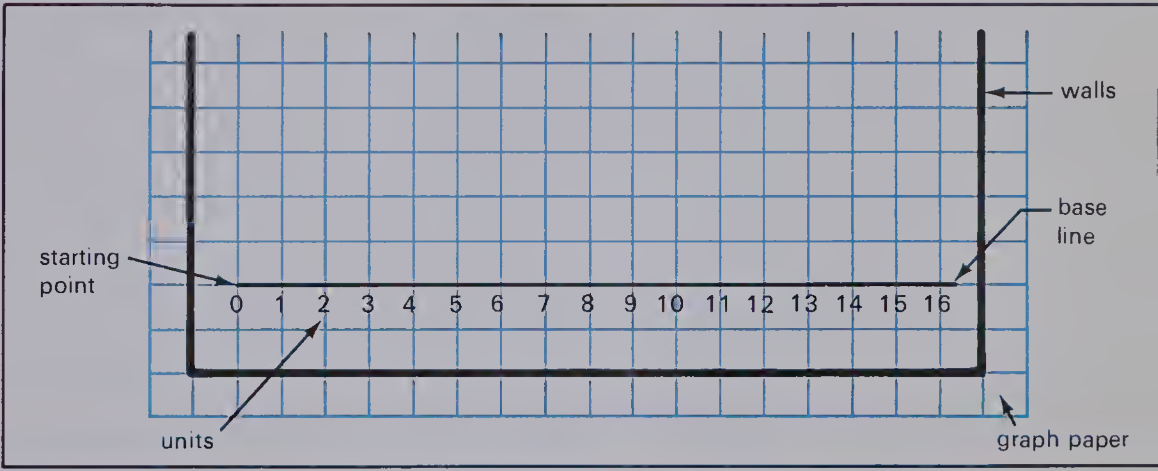
Step 1:

Turn the graph paper so that it best matches the shape of the room. Draw a base line in the same location as the real base line. Place the starting point on the base line in the proper location.

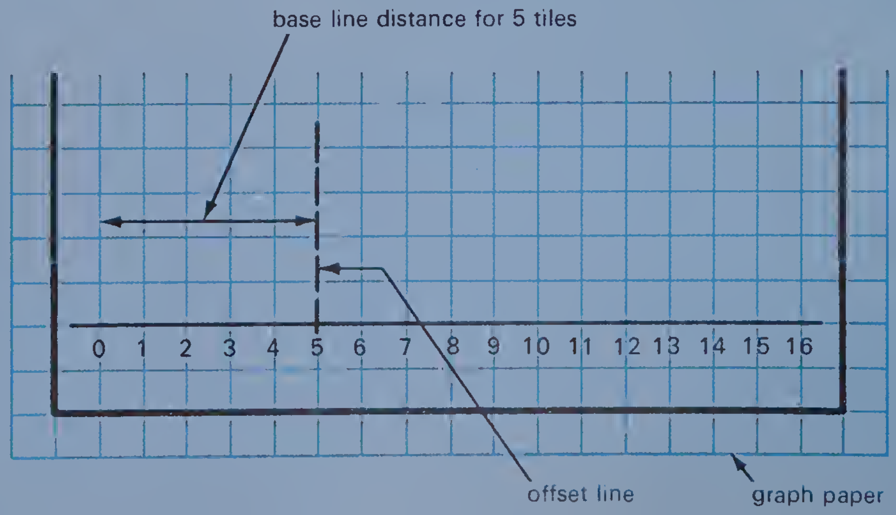
Beginning at the corner of one square, label your starting point as zero, and number the base line so that the next boundary of each square will be one unit, as shown in the diagram. Be sure to put the unit numbers on the lines of the graph paper and not in the spaces between the lines.

Step 2:

Start with the first object listed on the data sheet. Count along the base line, from the starting point, the same number of units that you obtained when you measured for that object. Mark this point with a dot on the base line. The line on the graph paper at right angles to the base line and passing through the dot will represent the offset line.

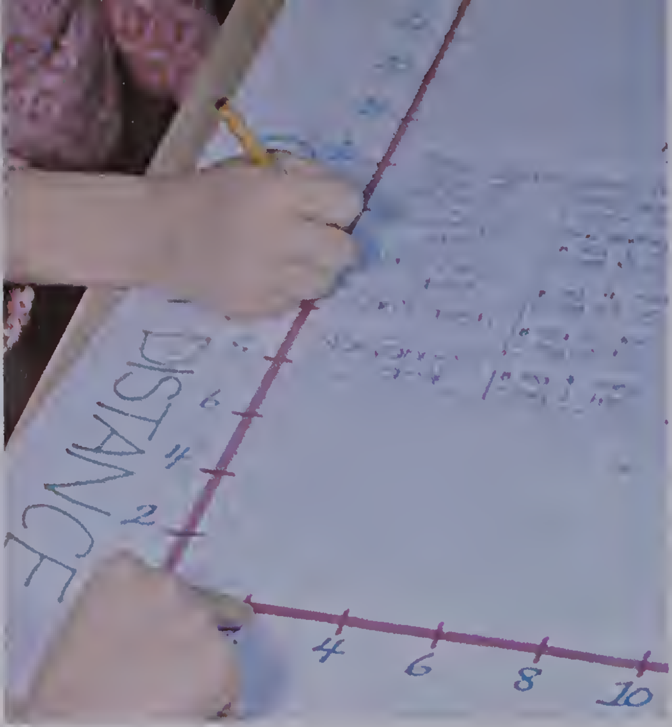


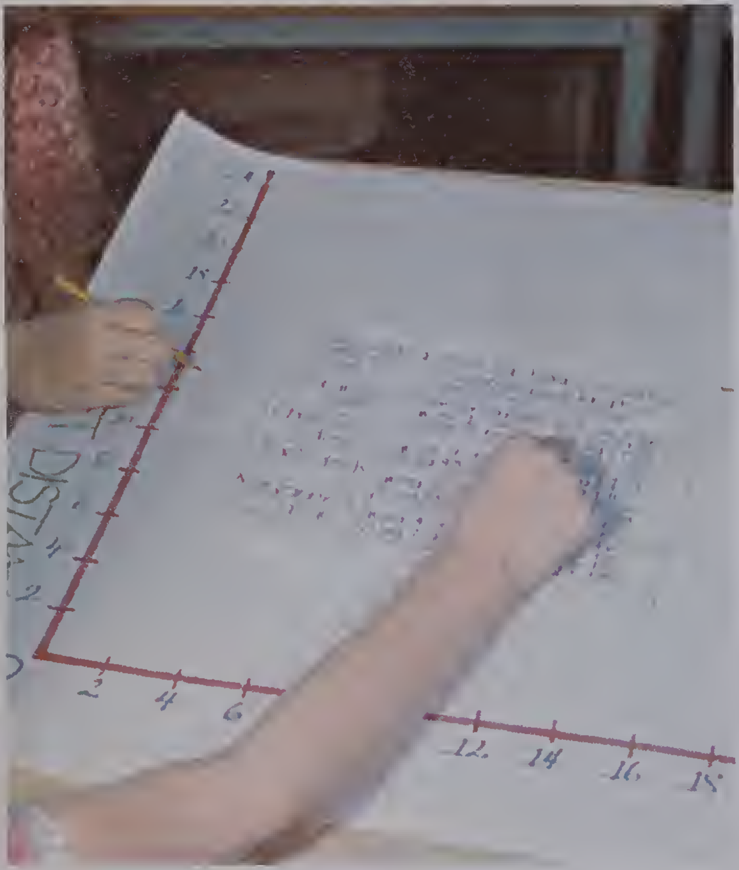
OBJECTS SURVEYED	BASE LINE DISTANCE	OFFSET DISTANCE	OTHER MEASUREMENTS
Chair A Leg #1	5 Tiles		



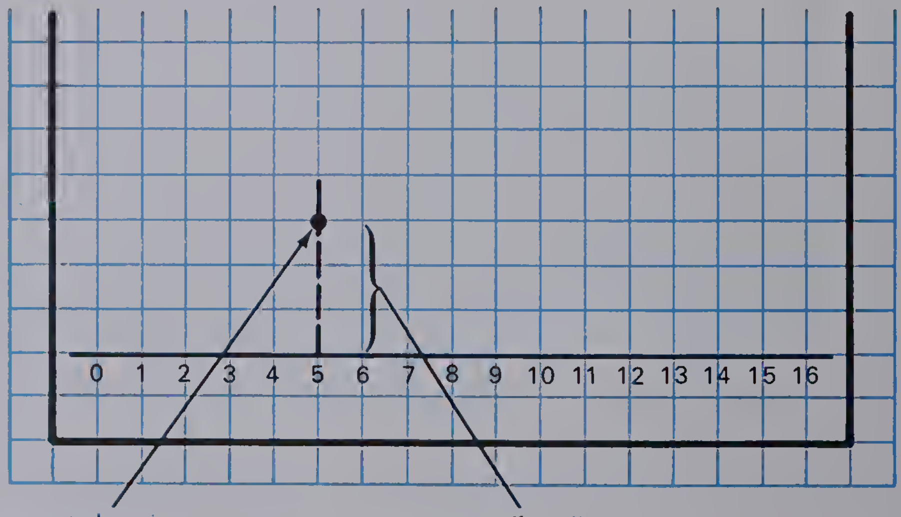
Step 3:

Beginning at the dot on the base line, count, but do not draw, along the offset line the same number of units that you measured as the offset distance for the first object on your data sheet. Mark this point on the offset line with another dot. This spot represents the exact location of one part of the object.





OBJECT SURVEYED	BASE LINE DISTANCE	OFFSET DISTANCE	OTHER MEASUREMENTS
Chair A Leg #1	5 Tiles	3 Tiles	



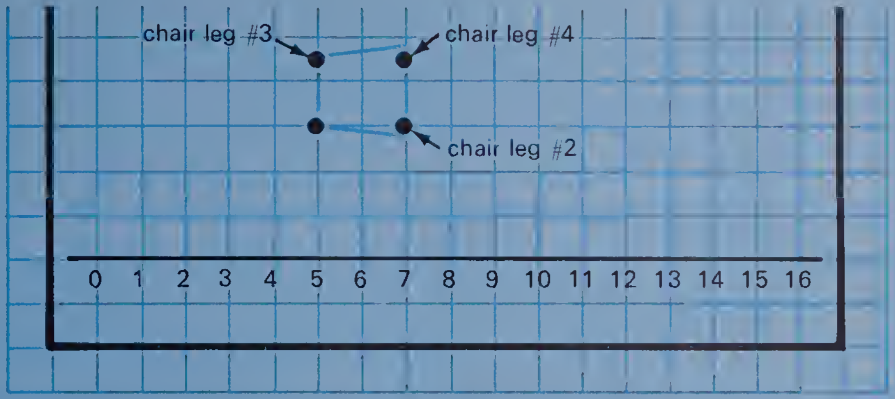
accurate location of chair leg #1

offset distance

Step 4:

Repeat Steps 2 and 3 for each item of information which you have on your data sheet for the first object that you surveyed. Draw a diagram of the object using the points that you located on the graph paper. Instead of a diagram, you may wish to use a symbol to represent the object.

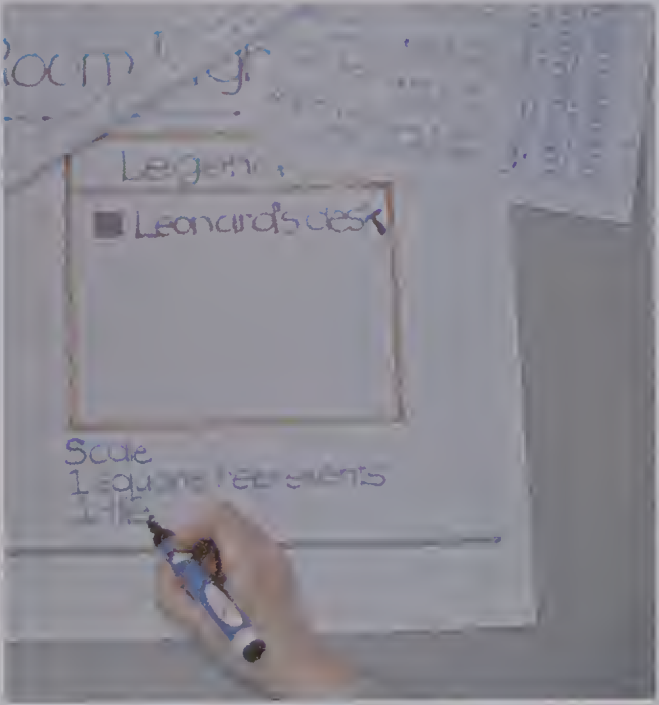
OBJECT SURVEYED	BASE LINE DISTANCE	OFFSET DISTANCE	OTHER MEASUREMENTS
Chair A Leg #1	5 tiles	3 tiles	Front 2 tiles
#2	7 tiles	3 tiles	Wide Back 1½ tiles wide
#3	5 tiles	4 ½ tiles	
#4	7 tiles	4 ½ tiles	

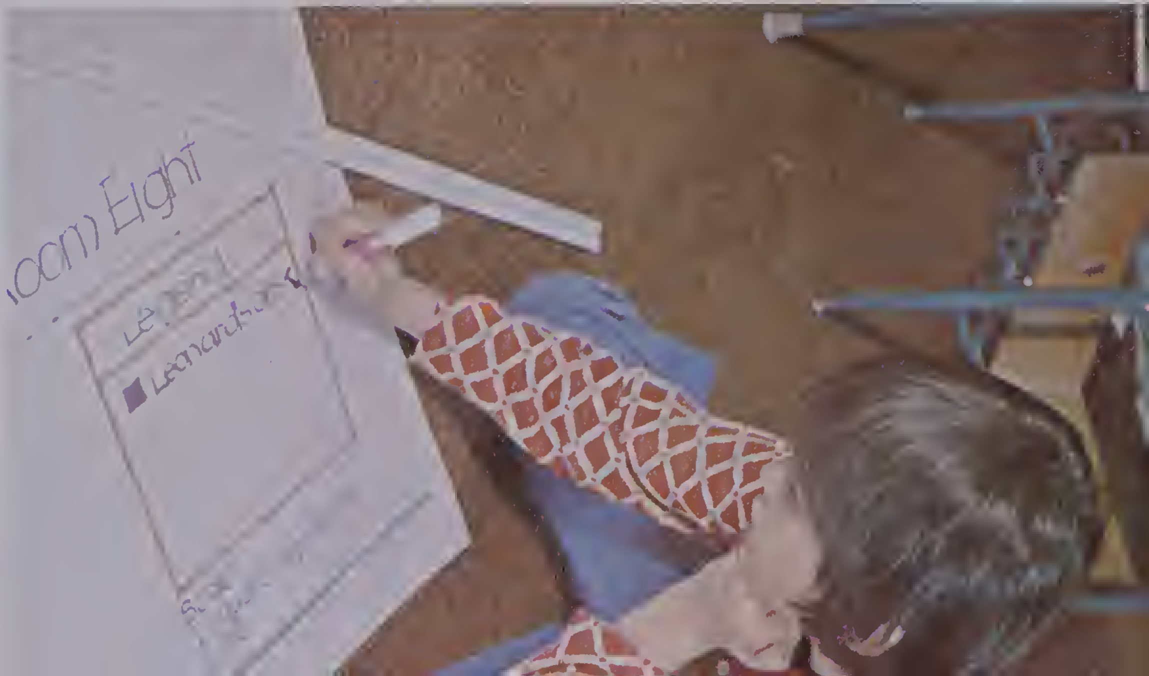


Step 5:

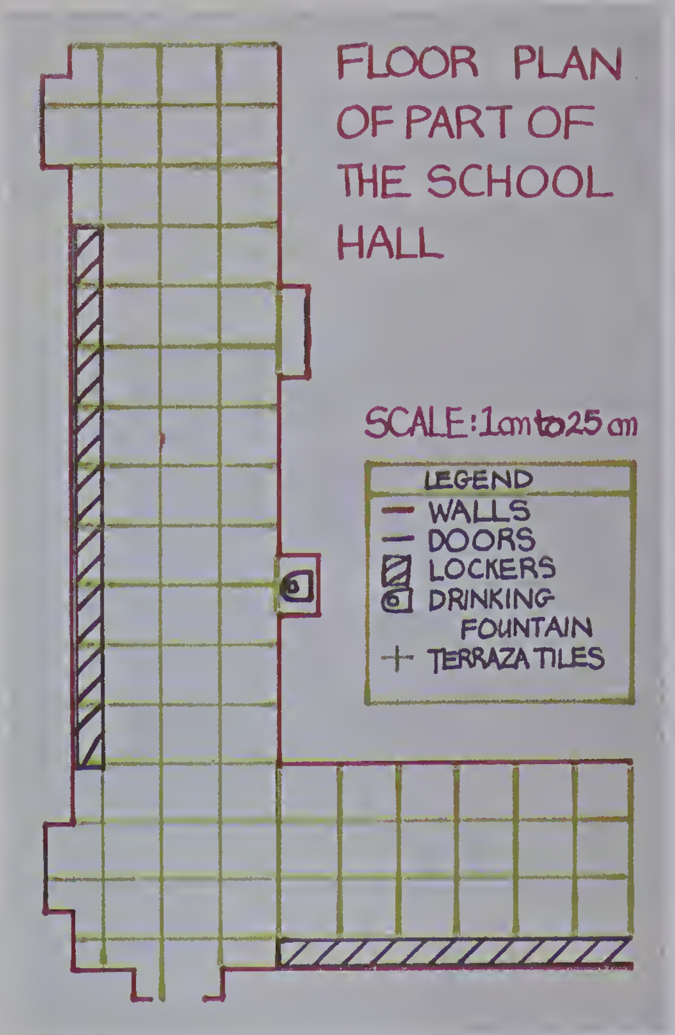
Repeat Steps 2, 3, and 4 for the other objects listed on the data sheet.

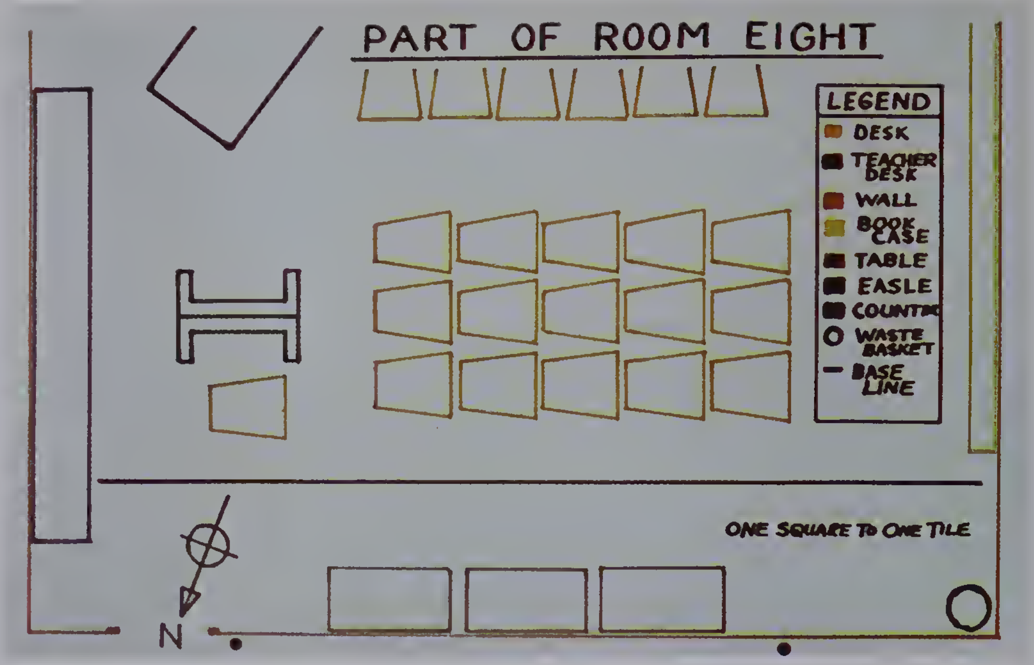
Add to your map as many of the features as you can that you learned about in Chapter 1. These might include a title, a legend, a scale, and a compass rose.





What map feature is being added in each of these photographs?





What objects have been located on these floor plan maps?

Digging Deeper

Why was it so important to write the information on a data sheet before placing it onto the map?

Why was the map first made in pencil? What parts should be rubbed out when the map is completed?

If the sheet of graph paper was not large enough to allow you to locate all the objects, what could you do to make the sheet larger?

What could have been done with the units and the squares in order to make the map smaller?

If you had divided your base line on the floor into 25 cm units and your graph paper contained centimetre squares, what would the scale of the map have been?

In what other ways could you write or draw a scale of 1 cm to 25 cm?

Suppose you had drawn the base line along the left side of your graph paper. In which directions would you have counted off your measurements?

Could the base line and offset method be used accurately on the side of a sloping surface? over the crown of a hill? Why? In what other locations is the base line and offset method not suitable for gathering map-making information?

What measuring device, in addition to a pencil and a ruler, would you need to make this map on plain paper if you could not use graph paper?

Activity 4:

How can the large measurements of a room be made small enough to fit onto your map paper?

Suppose that the floor of the room that you measured is 15 m long and 10 m wide, but the paper on which you are going to draw your map is only 24 cm long and 20 cm wide.

In order to fit a large area onto a small piece of paper, map makers use a *scale*.

First you should plan your scale. To do this you need to know two measurements:

(a) the length and width of the paper on which you are going to draw your map;
(b) the length and width of the area that is being mapped.

If the shape of the area is not a square or a rectangle, select the longest length and the longest width.

If the longest length is in metres and centimetres, round off the distance to the next highest metre. For example, 14 m 60 cm would become 15 m. This is called the approximate length.

Since the size of your map paper is more conveniently measured in centimetres, while the room is more easily measured in metres, it is necessary to calculate how many metres will be represented by one centimetre on your map. This can be found by dividing the approximate length of the area being mapped, by the length of the map paper. If the answer contains a fraction, raise it to the next whole number.

Approximate length = 15 m
Length of map paper = 24 cm

$$\frac{15}{24}=\frac{5}{8}=1$$

The scale of this map would be "one centimetre represents one metre" or "1 cm to 1 m".

Now use the scale selected to change each measurement that you recorded. For example, if you are using the 1 cm to 1 m scale, a real distance of 15 m would require a line that is 15 cm long on your map. Using the same scale, how long would real distances of 19 m, 28 m, and 44 m be on your map?

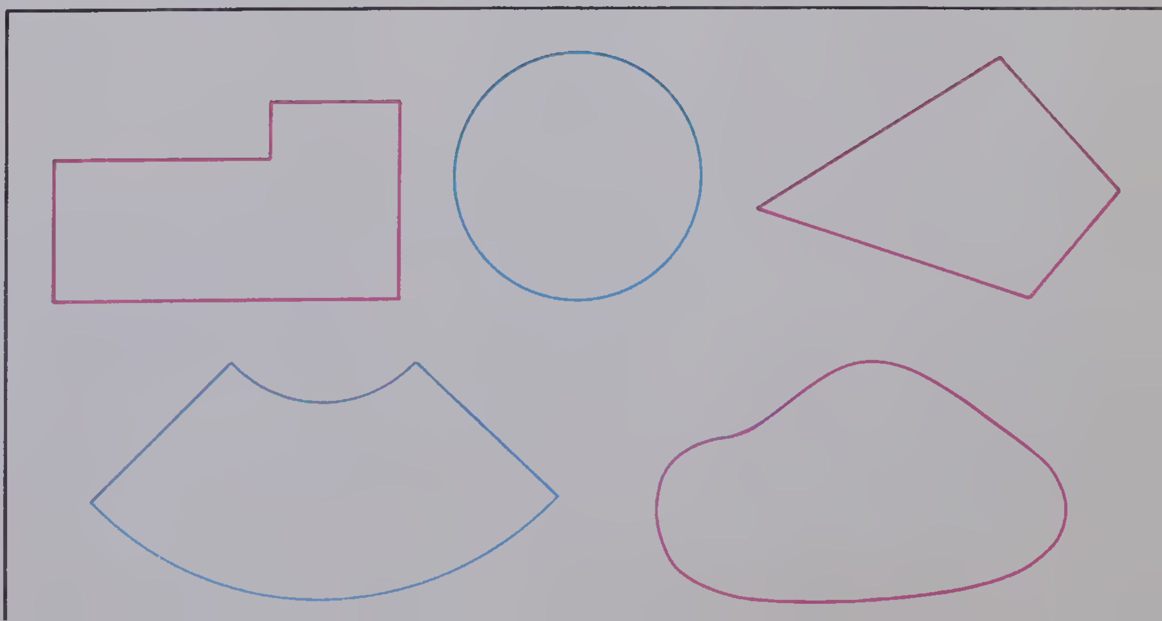
If your graph paper has 1 cm squares and your scale is 1 cm to 1 m, then each side of a square represents 1 m. How much of one side of a square would represent 50 cm? How many squares would be needed for a measurement of 3 m?

Each map that you make should have a scale on it. For ways in which the scale can be drawn or written, see page 16.

Plan a scale for your map of the room that you measured. Use this scale to help you draw a map. Be sure to add the scale that you used to the map when it is completed.

Digging Deeper

Where would the longest length and width be measured for each of these shapes?



Size of cm² graph paper	Longest length and width
60 cm x 50 cm	35 m and 20.8 m
30 cm x 25 cm	5 m and 4.2 m
20 cm x 30 cm	15 cm and 10 cm

What would a suitable map scale be for each situation in the chart? What would the scale be if the graph paper has cm squares? 2 cm squares?

What would the approximate length be for 12 m 40 cm?
9 m 75 cm?
22 m 65 cm 8 mm?

What would be the scale if, in your calculations, you used the width measurements, instead of the lengths, given at the beginning of this activity?

How could you be certain that the longest width would fit on your map paper?

Why must the same scale be used to change all measurements? Why must all the measurements be changed?

Why would graph paper with rectangles, instead of squares, not be suitable for drawing maps?

With a scale of 2 cm to 1 m, what distance would be represented by 4 cm? 8 cm? 11 cm? 50 cm? 120 cm?

With a scale of 2 cm to 1 m and graph paper with 1 cm squares, how many squares would be needed for 4 m? 10 m? 16 m? 25 m?

If the scale was 4 cm to 5 m, how long would a line on your map be for a measurement of 5 m? 10 m? 17.5 m? 35 m?

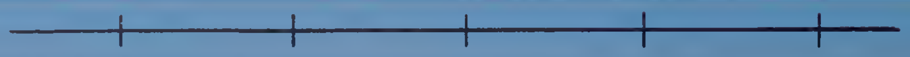
What is the rule for changing a measurement when a scale is used?

When the scale is written as a statement, for example, 2 cm to 1 m, which length is placed first? Why is the word "to" used instead of the word "equals"?

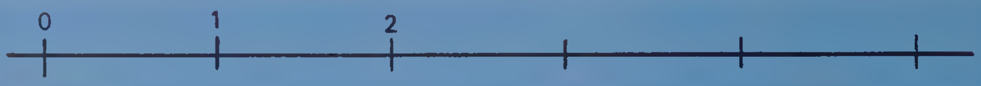
Branching Out

HOW CAN A STATEMENT OF SCALE BE CHANGED TO A SCALE LINE?

When words are used to tell what scale was used they are called a statement of scale. The statement of scale, 2 cm to 1 m, can be drawn as a scale line. To make the scale line, first draw a horizontal line. Using small vertical lines, divide the line into sections 2 cm long.



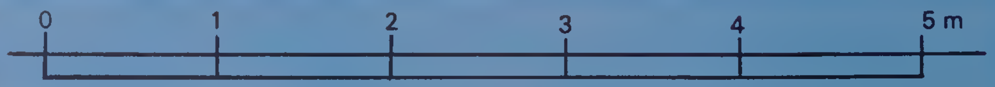
Label the first vertical line "O". Label the next line "1" and the next "2".



All numerals should be placed above the scale line.

What would be the numerals for the fourth and fifth vertical lines? Scale lines usually have four or five sections marked.

Finally, add the unit that the numerals represent at the end of the scale line.



If you wish, you can thicken the horizontal line and add color to dress up the scale line.

How far apart would the section marks be if the scale statement was 1 cm to 1 m? 0.5 cm to 1 m? 2 cm to 5 m? 1 cm to 5 m?

What is the fewest number of section marks a scale line could have?

What numbers could be placed at each section mark below the line?

Make scale lines from these scale statements: 1 cm to 3 m; 1 cm to 50 m; 0.5 cm to 25 m; 0.5 cm to 100 m; 0.25 cm to 1 km.

Activity 5:

How can the base line and offset method be used to map the location of objects and landmarks on the school grounds?

Select some part of the school grounds that would form a good base line. You might use the sidewalk or a fence. Use your measuring string and a piece of chalk to divide the base line into units. Be sure to remove the chalk marks with a damp cloth later.

Decide what objects will appear in your map. These might include buildings, driveways, trees, bicycle racks, flagpoles, gardens, steps, and so on.

Make a chart in which to record the base line distance and the offset distance for each object you selected.

Use a piece of cardboard with a square corner and a measuring string to measure the offset distance from the base line to each object.

In order to draw your map so that it will fit onto the graph paper, you will probably have to select a scale. Try letting one unit on the graph paper be one metre on the ground. If you cannot fit the long distances you measured onto your paper using this scale, then try one unit to two metres or more.

When you have located all the objects that you measured, draw in their outlines or use symbols to represent the objects.

Finally, add the title, compass rose, legend, and scale.

These students are using the sidewalk, the measuring line, and the square corner to map the schoolyard.

Digging Deeper

Why would larger units such as metres be suitable for this activity?

What parts of this activity will need two or more people working together?

How could a second measuring string have been used as a base line?

Why should the chalk marks be removed as soon as you have completed your surveying?

Which parts of this activity were map drawing and which parts were surveying?

What were some other good locations for base lines?

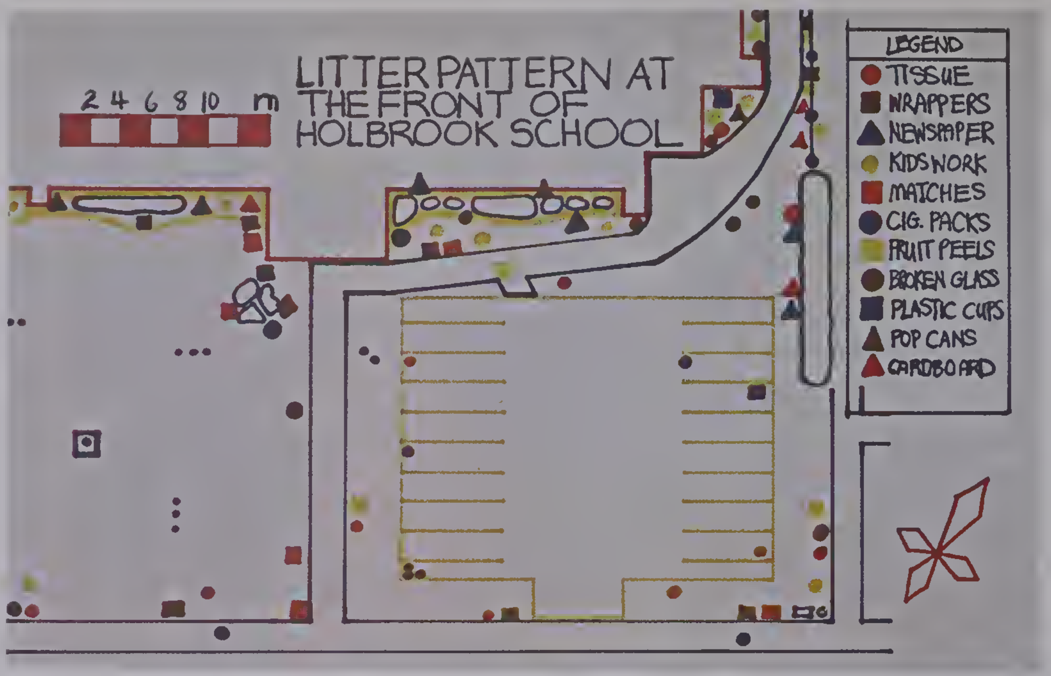
What would a scale line look like for a scale statement of 1 cm to 5 m? 1 cm to 8 m?

Branching Out

HOW CAN YOU USE THE BASE LINE AND OFFSET METHOD TO DETERMINE WHERE LITTER IS FOUND ON YOUR SCHOOL GROUNDS?

Use the same base line with which you located the landmarks on the school grounds. Measure the base line and offset distances for large pieces of litter. Record your information in a chart.

Use the map of the schoolyard and the information in the chart to add the locations of litter to your map of the schoolyard. Use a different symbol for each type of litter: candy wrappers, pop cans, newspapers, apple cores, tissues, and so on. Be sure to add another key to your map.



Near what object or landmark was the most litter found?

Which type of litter was the most common?

Where would be the best place to locate a litter basket?

How would this map compare with a litter map of your schoolyard?

Activity 6:

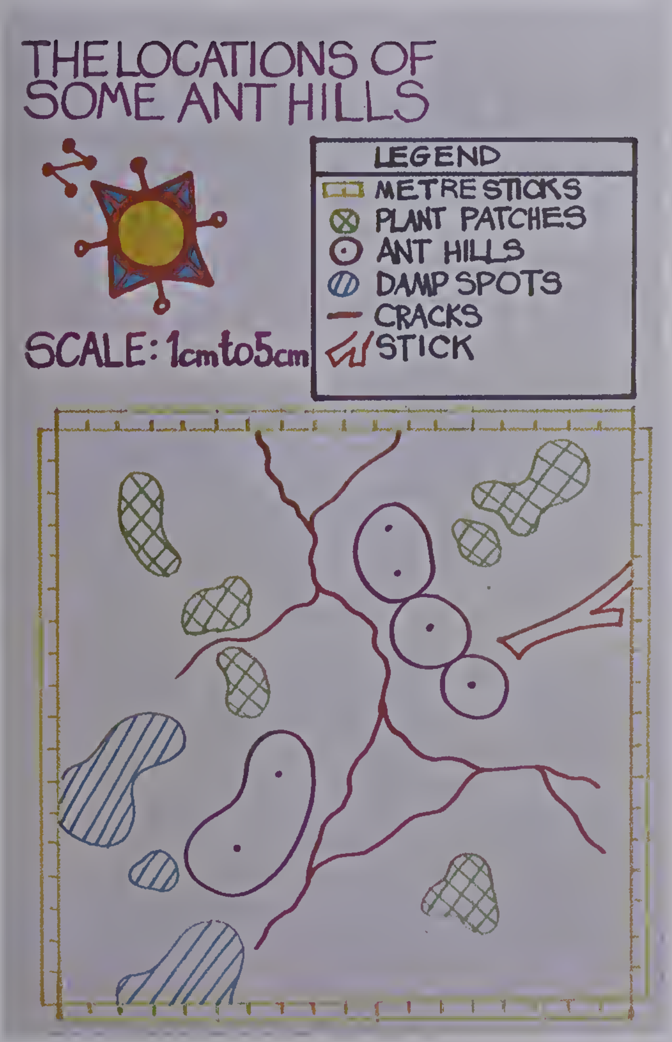
Do ants make their burrows in any particular pattern?

Find an area of a lawn, field, or garden that has a number of ant hills. Place four metre sticks on the ground so that they form a square around the ant hills.

How are the locations of the ant hills being measured?

Choose one metre stick to be the base line and another for the offset distances. Use two broom handles or other straight sticks to help to measure the location of the entrance to each hill.

Make a sketch on which to record your measurements of the area. Use the information in the sketch to accurately locate the ant hills on graph paper. Use a scale of 1 square on the graph paper to 5 cm on the ground.



Digging Deeper

Where should the zero end of each metre stick be located?

Why were four metre sticks used instead of just two?

Are ant hills usually about the same distance apart?

What is the closest distance between ant hills?

How could you use a ruler to check the accuracy of the distance between the ant hills?

Does an ant hill ever have more than one entrance?

How could the edge of each ant hill be added to your map?

Branching Out

HOW DOES A RAINSTORM CHANGE THE EROSION PATTERN IN SOIL?

Find a place where flowing water has washed out small gullies in the soil. A good place to look would be at the edge of a garden or along the bottom of a ditch.

Place a metre stick beside the gullies and mark the ends with popsicle sticks so that you can replace the metre stick in exactly the same spot later. This ruler is the base line. Use another ruler and a square cardboard corner to measure the offset distances to points along the gulley. Be sure to measure to both sides of each gulley that you select. This will let you draw the width of the gulley accurately when you make your map. Record your data on a rough diagram and then draw the map accurately.

If it does not rain as quickly as you would like it to, create your own shower with a hose or watering can.

How could a map be used to find the effect of rain on this erosion pattern?

Replace the base line and use the diagram to help you remeasure the gullies at exactly the same points you did before. Draw the gullies on the same map, but use a different color.

Why should two colors be used in drawing the erosion gullies?

How could you tell where new gullies had formed?

At what places had the gullies become wider?

Why was it very important to locate the base line and make the offset measurements in exactly the same place each time?

How can a sheet of plastic and a magic marker be used to map the cracks in the pavement?

ARE THE CRACKS IN ASPHALT SIMILAR TO THE EROSION PATTERN IN SOIL?

Use a metre stick to accurately measure the larger cracks in a piece of old asphalt pavement. Draw a map of this small area on the thinnest type of paper you can find. Make a tracing of the same area shown in your map.

To make a tracing, place over the area a sheet of clear plastic from an overhead projector.

Trace the edges of the cracks using a magic marker.

Place the map over the tracing so that the dark lines match the lines on your map. How accurate was your map?

Compare the asphalt crack map with the erosion gulley map. Try to find such differences as number of branches, amount of twisting, and so on.

Try this activity with an interesting section of tree bark.

Activity 7:

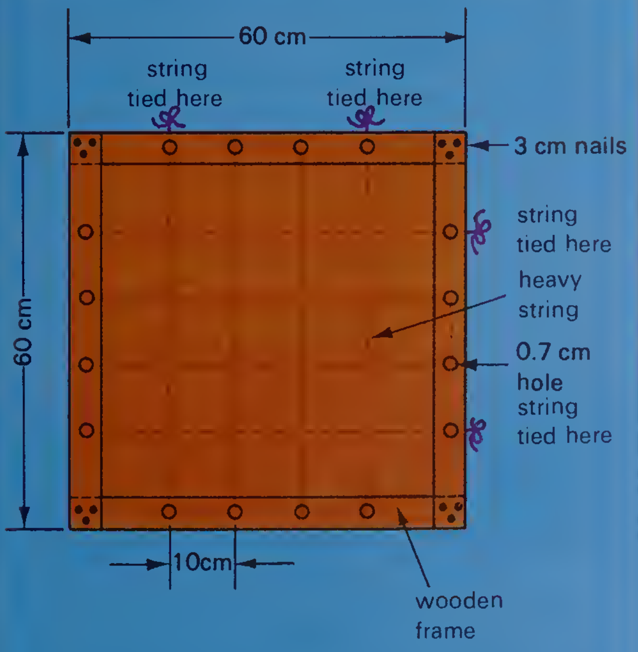
How does walking on a lawn alter the plants that grow there?

A device that is useful for mapping is called a *grid frame.* Examine the plans and photographs to see if you can find the grid and the frame parts.

To make a grid frame you will need these materials:

4 pieces of wood, 2 cm thick, 5 cm wide, and 60 cm long;
6 m of strong string or butcher's cord;
12 common nails, 3 cm long;
white glue;
a hammer;
a drill with a 7 mm bit.

Construct a grid frame similar to the one shown.



A Grid Frame

The equipment needed to build a grid frame.

A completed grid frame.

Prepare two data sheets that are divided into the same number of squares as there are in the grid frame. Number the squares.

Carefully choose two areas of a lawn. One area should be a part that is hardly ever walked on. The other area should be a place along a path or near the edge of the lawn where many people have walked.

Place the grid frame on the ground in one of the areas that you have selected. Start with the square of the grid that corresponds to square one on the data sheet. Use symbols to draw on your paper the accurate location of the stones, dirt patches, twigs, ant hills, papers, plants, and any other objects found in that square. Use a different symbol for each new type of plant you find. Make a legend, and each time you use a symbol, add it to this key. When you have completed square one

What could a grid frame tell you about an area such as this?

proceed to square two and so on. When the first area is finished, move the grid frame to the second area and do the same thing there using the second data sheet.

On returning to your classroom, draw the map of the two areas neatly and accurately. Add color, a title, and other information that you feel the maps should have.

Digging Deeper

What was the average number of plants in each square? in each area?

In which area were the plants farther apart?

Which area had more dirt patches, stones, and other objects?

Which area contained more evidence of insect life?

In how many ways can an area be changed by continually walking on it?

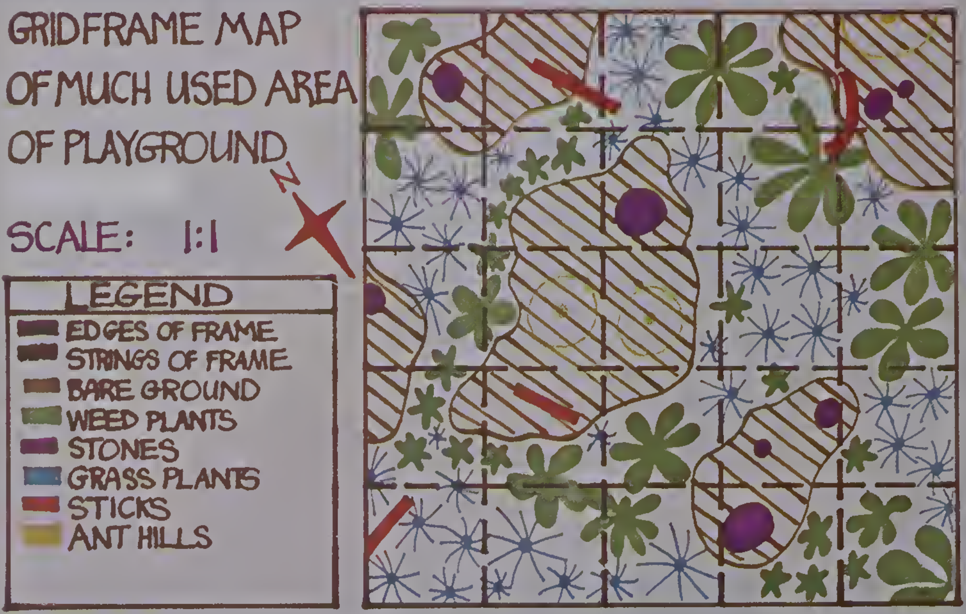
By having 25 squares in the grid frame, what arithmetic could be done to easily change the numbers that you counted into percentages (4 x 25 = 100)?

How is the base line and offset method applied when you use a grid frame?

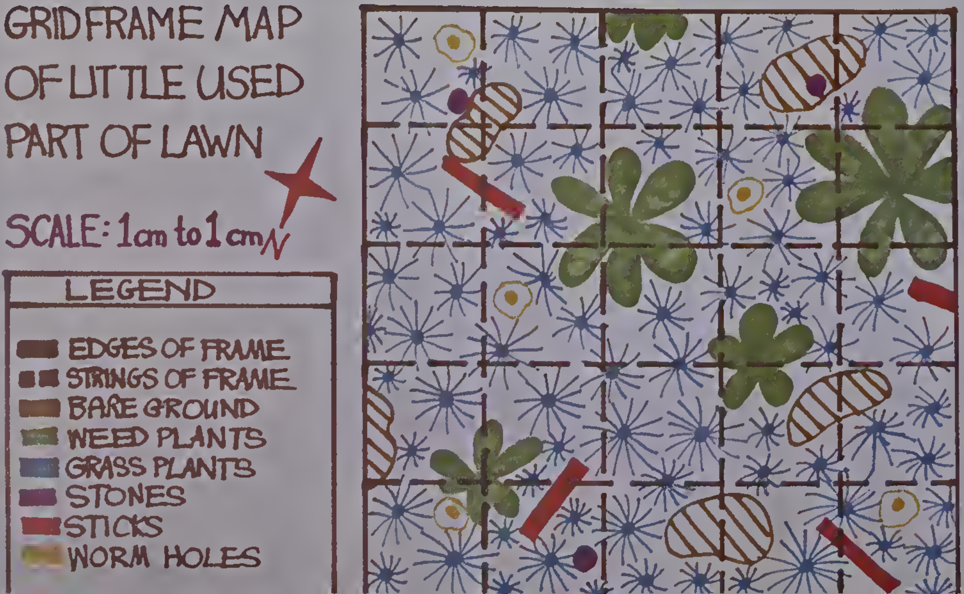
Branching Out

Use your grid frame to find out how the plant life in a field is different from the plant life on a lawn.

How is a new, well-cared-for lawn different from an old one that has been neglected?



What are the differences between the two areas shown in these maps? What do you think caused the differences?



Activity 8:

In which direction is your base line pointing?

In order to find the direction of the base line, you will need a *compass.*

Hold the compass level so that the needle can swing freely. Place it on, or right beside, the base line.

Turn the whole compass or the compass housing slowly until the letter N on the compass rose and the north end of the needle are in line. Usually the north end of the needle is colored differently from the rest of the needle. This color often matches the color used for the letters.

Wait until the needle stops moving. The compass is now *oriented* to the North Magnetic Pole of the earth.

Place a toothpick on top of the compass housing so that it is pointing in the same direction as the base line. The toothpick should also pass right over the center of the compass. Read the letters (or numerals) on the compass rose that are under the toothpick. These letters describe the direction in which the base line is pointing. Write down these letters before you forget them. As your skill increases you may not need to use the toothpick to help you find the direction of the base line. Sometimes, the compass can be placed right on the base line instead of using a toothpick.

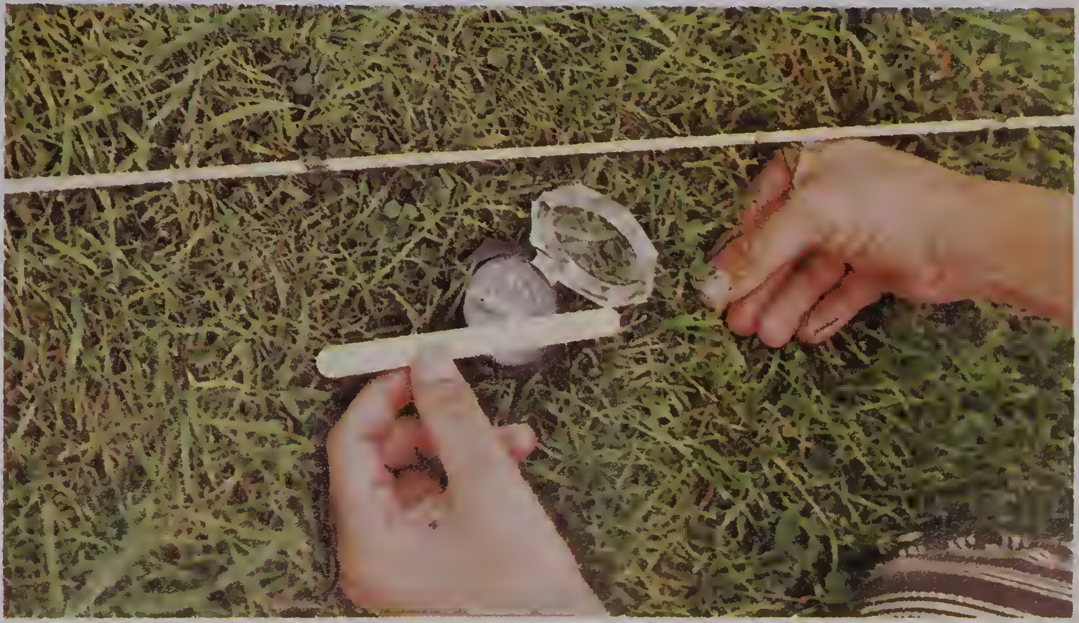
The compass can be used in a similar manner to help you draw a compass rose on your map.

Place the compass on the base line that you have drawn on your map so that the base line passes through the center of the compass. Turn the compass so that the same letters that were under the toothpick are over the base line.

Turn the map until the north end of the needle points to the letter N on the compass rose. The map and the compass are now oriented to the North Magnetic Pole of the earth.

Draw a line on your map that is pointing in the same direction as the needle of the compass. Label the north end of this line with a capital letter N. Add any other letters or lines from the compass

In what direction is this line running?



What must be done before a compass rose can be accurately placed on a map?

rose that you like, depending upon how fancy you wish to make the compass rose on your map.

Add a compass rose to as many of the maps that you have already drawn as you can.

Practice with a compass to find the direction of the walls and corners of your room. Look out of a window and find the direction to the nearest church steeple or tall chimney. Select a spot on your school grounds and find the direction from there to the sun at several times during the day.

Digging Deeper

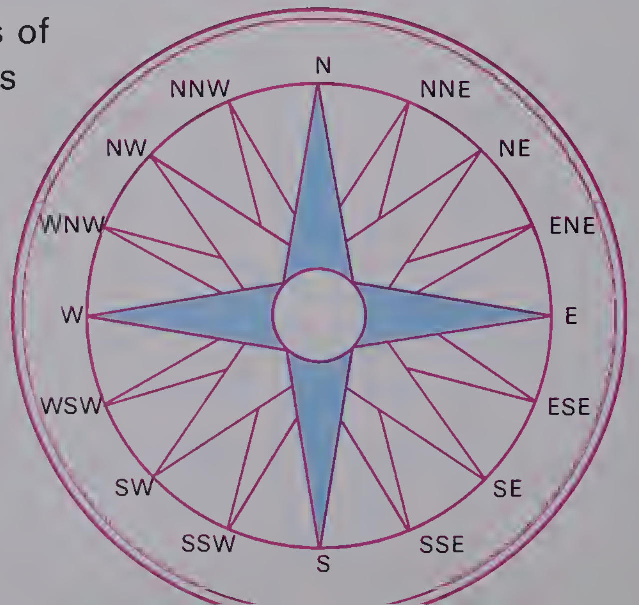
Hold a nail or some other object made of iron or steel near the compass. What happens to the needle? What happens to the needle if you move the nail? How close to the compass must the nail be for the needle to do this? Do any parts of your clothing affect the compass needle in the same way as the nail?

The letters on the compass rose are called its *points*. Inexpensive compasses usually show only four or eight points. How many points does your compass show? If the point halfway between NW and N is called NNW, and the point halfway between N and NE is called NNE, what would the other halfway points be?

What could you do to be more accurate if the base line is found to be halfway between two of the compass points?

Without looking at your compass, is east on your right or left when you are

The Points of A Compass



facing south? Check to see if you were right.

How would you use a compass and the compass rose on a map to turn the map so that the N of the map's compass rose is pointing to the north and the map is properly oriented?

Branching Out

Visit a hardware, sporting goods, or other store where compasses are sold. Examine as many types as you can. Why do some compasses cost more than others? How are *orienteering* compasses different from other types? What is sometimes placed inside a compass to slow down the movement of the needle? What colors are most compass needles? How are the compasses used on ships or planes different from the compass you used?

Special names are given to the two groups of compass points: N, E, S, W, and NE, SE, SW, NW. What are these names?

How could you use your compass to test the accuracy of the belief that moss always grows on the north side of a tree?

Use your compass to test the accuracy of these other methods of finding north.

(a) At night, an imaginary line drawn upward through the two end stars that form the Big Dipper's pot will always point to the north.

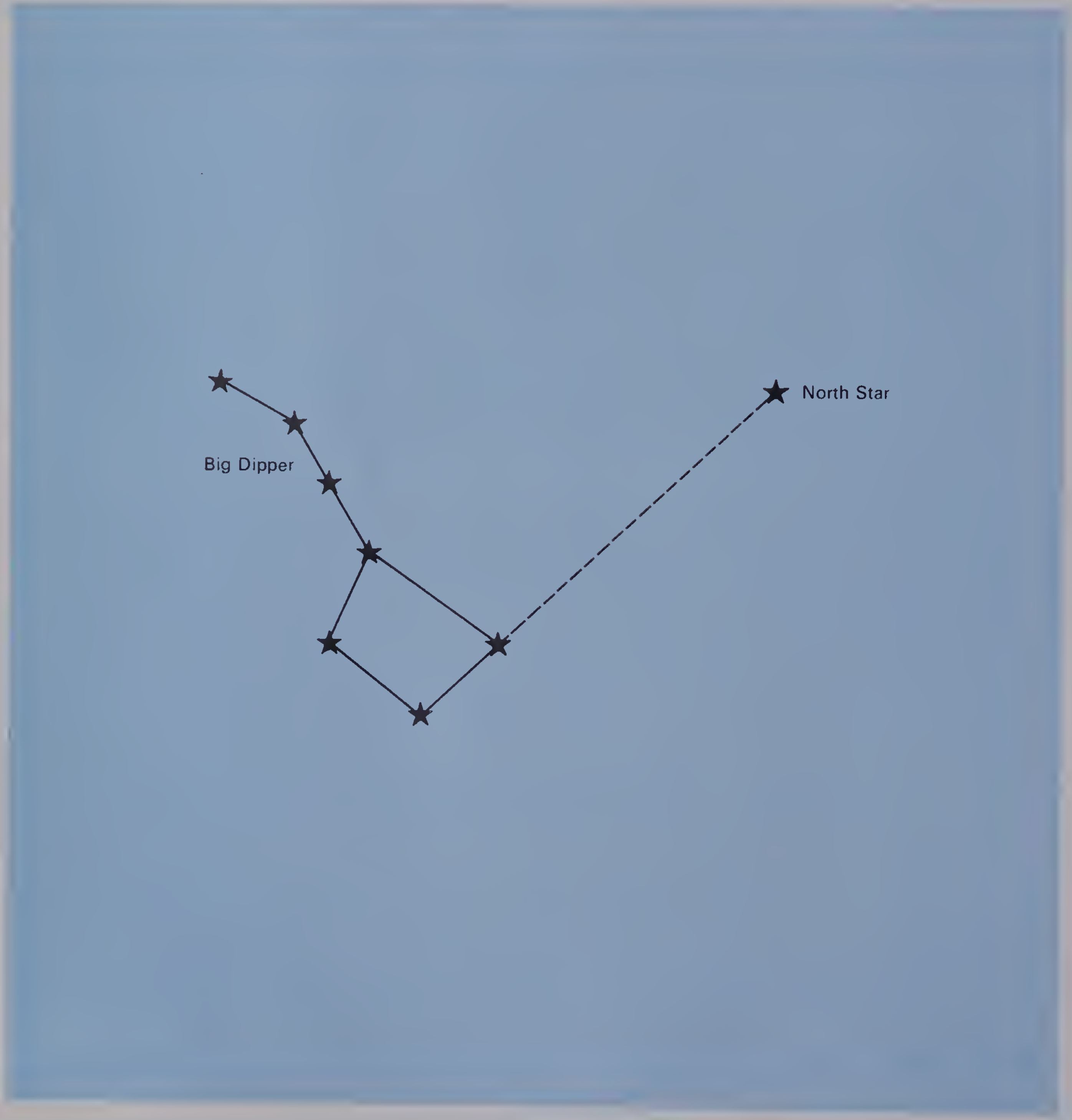
(b) In the daytime, at about noon, shadows point to the north. Would this also be true in daylight saving time?

Does moss always grow on the north side of trees?

Various compasses.

Do some research in library books or encyclopedias to answer these questions. How is the earth like a compass? What is the difference between true north and magnetic north? Where are the North Pole and the North Magnetic Pole of the earth located?

When using compass language, the word ''by'' is often used. What does this word mean? What would north by northeast mean?



How the Big Dipper can be used to find north. What is another name for the North Star?

Across And Down

3

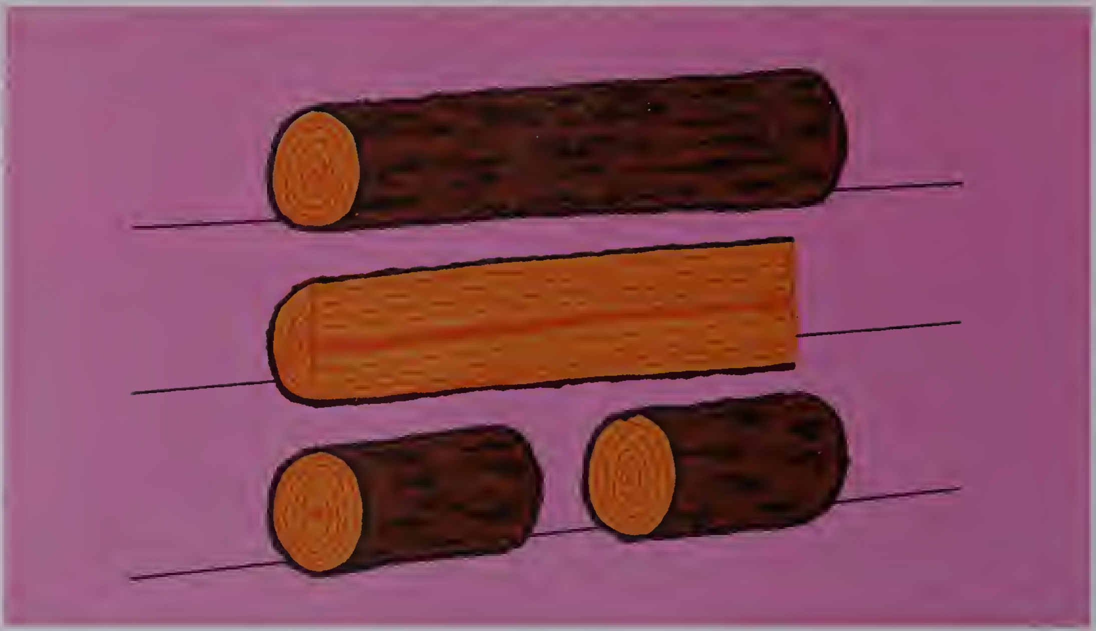
Maps which try to show directions that are measured across and down are usually called *cross sectional maps.* A cross section is the view you would see when you look at something from the end. If you cut a piece from a log and looked at the end, or if you split the log in half down the middle, what you would see is a cross section.

The base line and offset method can be used to obtain the data for cross sectional maps, but some changes are necessary. In cross sectional mapping the base line is called a *transect line.* The word transect comes from the Latin "trans", meaning across, and "sect-", meaning to cut.

Activity 1:

How can the transect line method be used to make a cross sectional map?

Place two similar chairs about 10 steps apart and facing in opposite directions. You may wish to put a pile of books on each chair so that it will not move or tip easily. Tie one end of your measuring string to an arm, support, or rung at the back of the first chair; tie the other end to the second chair at the same point. This string will be the base line. Stand back and look at the string. Does one end appear to be higher than the other? Measure from the string to the floor to see if you were right. Should one end be moved up or down? Does the string make a straight line? How can you prevent it from sagging? How do you know that the floor is not slightly tilted?



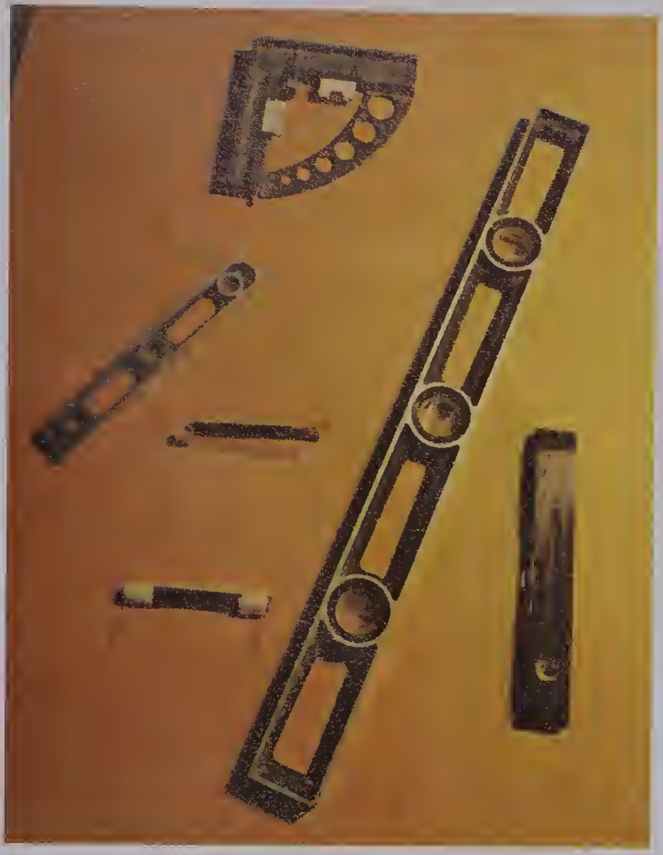
Which of these diagrams show cross sectional views? In what other ways could the log have been cut to obtain cross sections?

In locating the base line for making cross sectional maps, it is very important that the base line is not tilted. An object that is not tilted is said to be *level.* Your eye is a very poor instrument to measure an object to see if it is level. A much better instrument for this purpose is called a *level.* You can buy a line level at a hardware store for about 75 cents or you can make one using the plans and photographs shown.

You will need the following materials:
a clear plastic drinking straw;
a piece of thin cardboard, 5 cm wide and as long as the straw;
two paper clips;
cellulose tape;
food coloring;
an eye dropper.

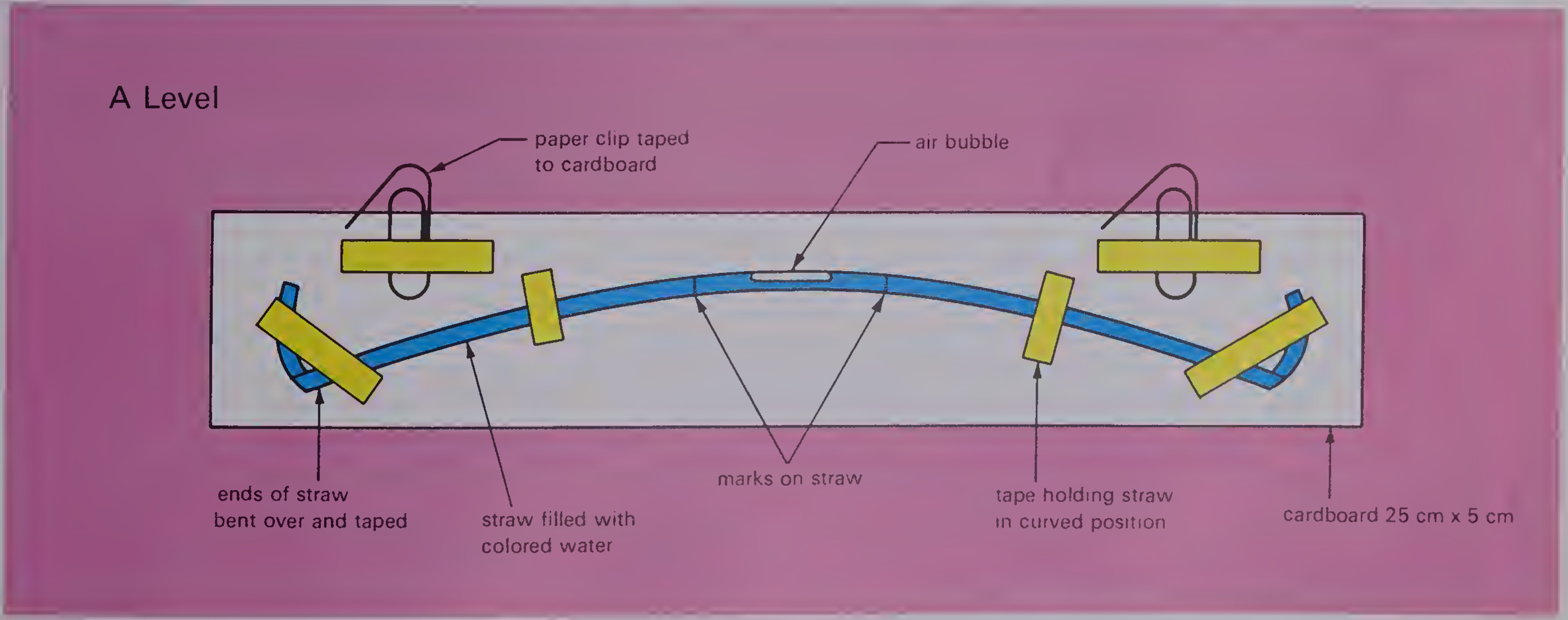
Materials needed to make a level.

Use this method to fill the straw with colored water.



Which of these levels would be suitable for use on a transect line?

A completed level.



A Level

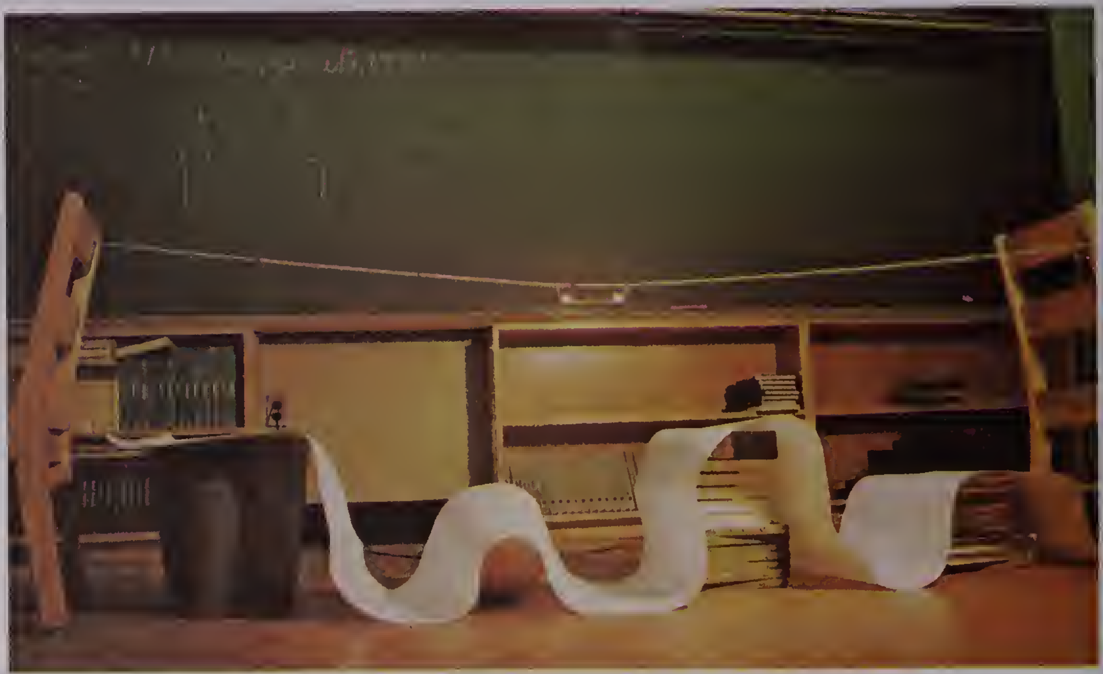
paper clip taped to cardboard
air bubble
ends of straw bent over and taped
straw filled with colored water
marks on straw
tape holding straw in curved position
cardboard 25 cm x 5 cm

Setting up a transect line.

Place a wastebasket, a pile of books, a large ball, a plastic jug, or other interestingly shaped objects on the floor between the chairs. Drape a bed sheet, a tablecloth, or a length of mural paper over the objects.

Hook your level to the middle of the string so that it hangs by the paper clips. Slide one end of the string up or down the part of the chair to which it is tied until the air bubble stays halfway between the marks on the tube.

You will remember from other activities that it was very important to have the offset make a right angle with the base line. You could use your cardboard corner for this purpose, but surveyors use another method. You found that it was important not to have the transect line sloping. It is just as important not to have the offset line tilted to one side or the other. When a vertical line is not tilted it is said to be *plumb*.

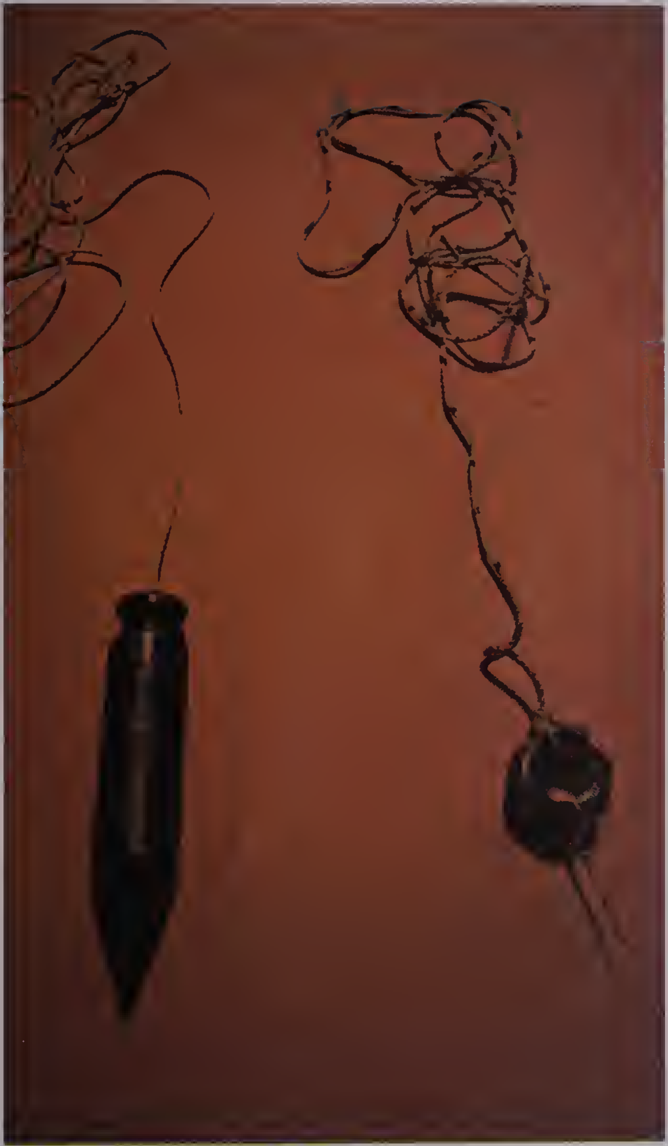


Using a level on the transect line.

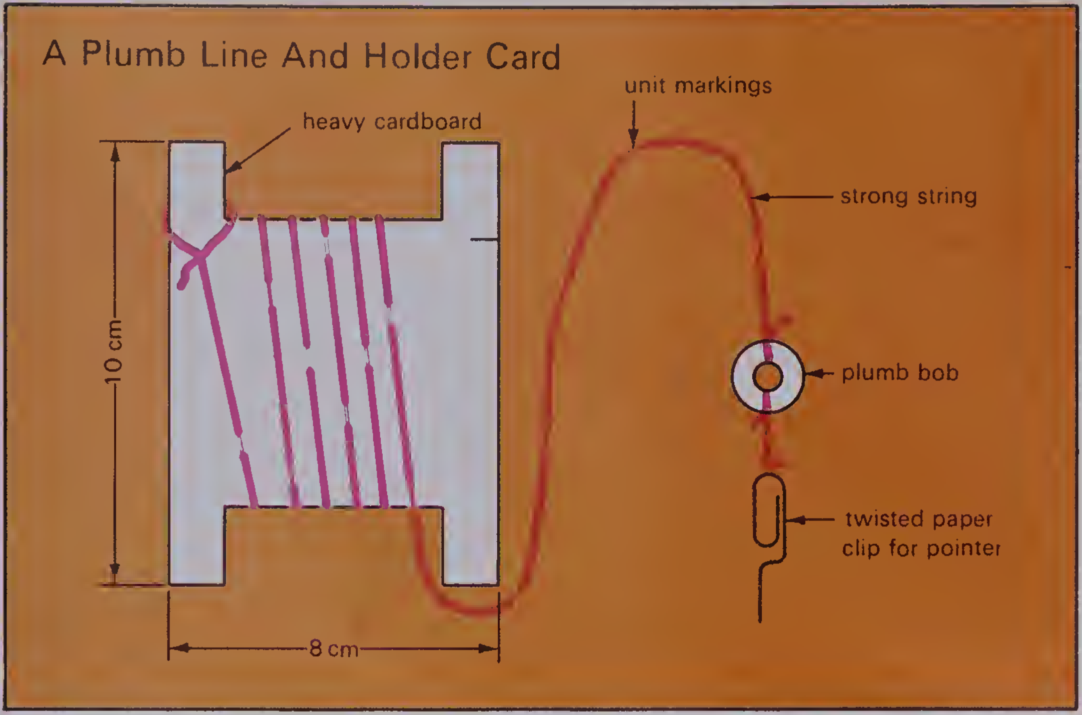
To help make the offset line hang plumb, a mass such as a large washer, a sinker, or the nut from a bolt, can be tied to the line. This mass is called a *plumb bob*.

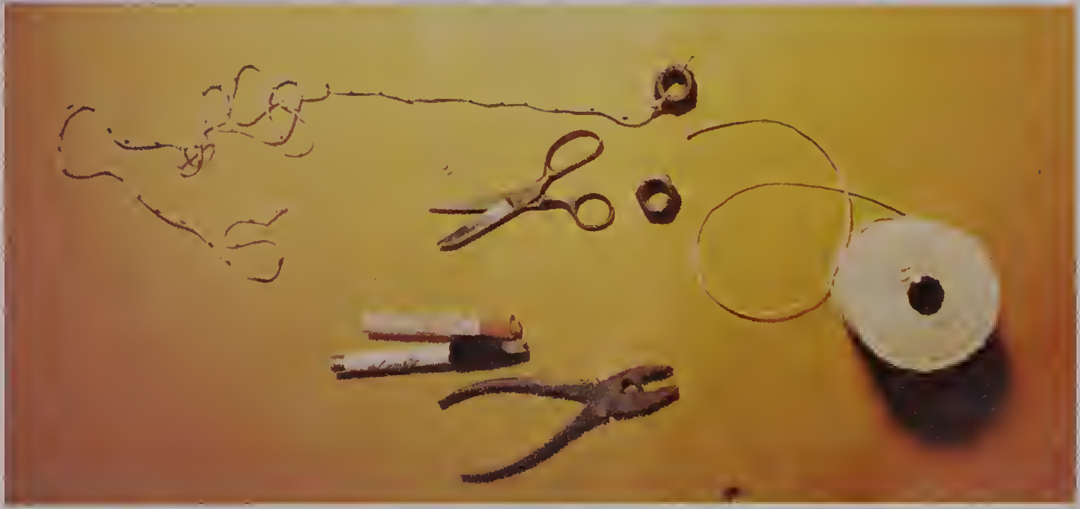
The plumb bob and string are called a *plumb line*. The plumb line can also be used to measure distances if it is divided into units. In order to measure offset distances, you will need a plumb line marked off in 5 cm units. Make a plumb line and holder like the one shown in the plans and photographs.

Two plumb lines.



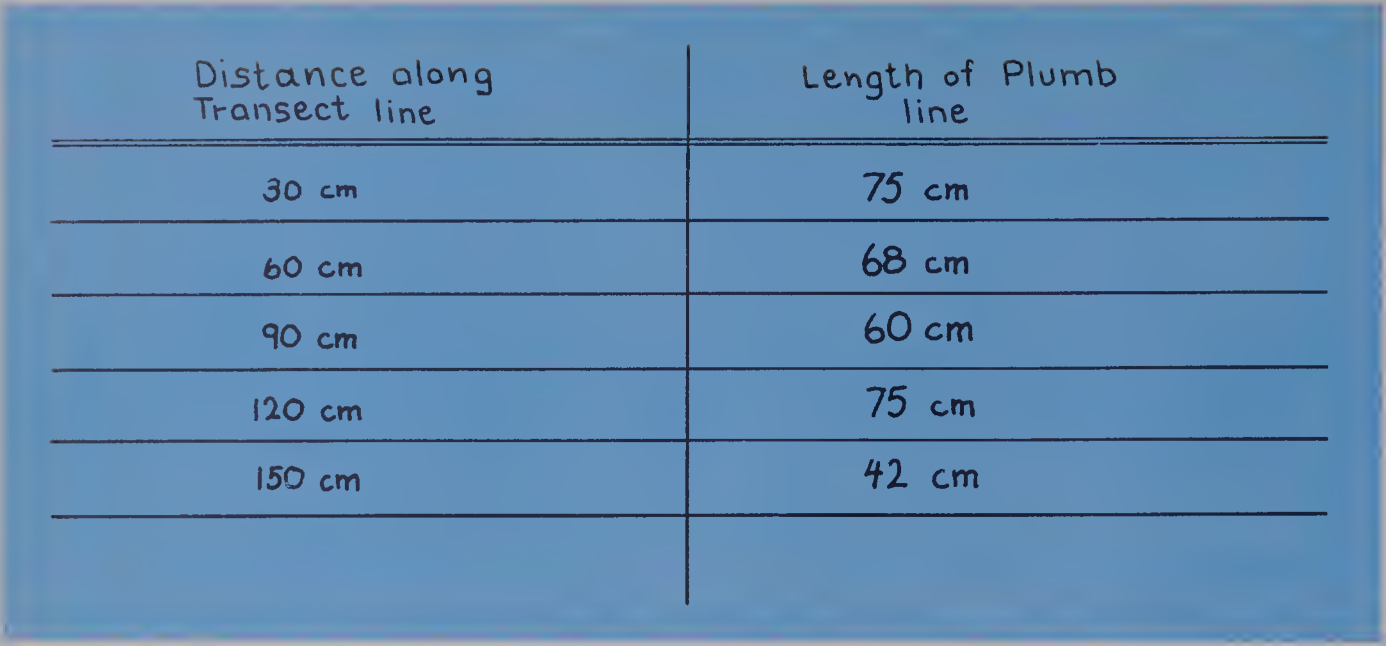
To use your plumb line, lower it beside the transect line until it almost touches the mural paper or cloth. Be sure to wait until the plumb bob stops swinging. Count the units from the plumb bob to the transect line. Count the units from one end of the transect line to the plumb line. Repeat this procedure at each unit marking on your transect line. Remember to always count from the first unit mark near one end of the transect line. This unit mark will be your starting point.


A Plumb Line And Holder Card



Materials needed to make a plumb line.

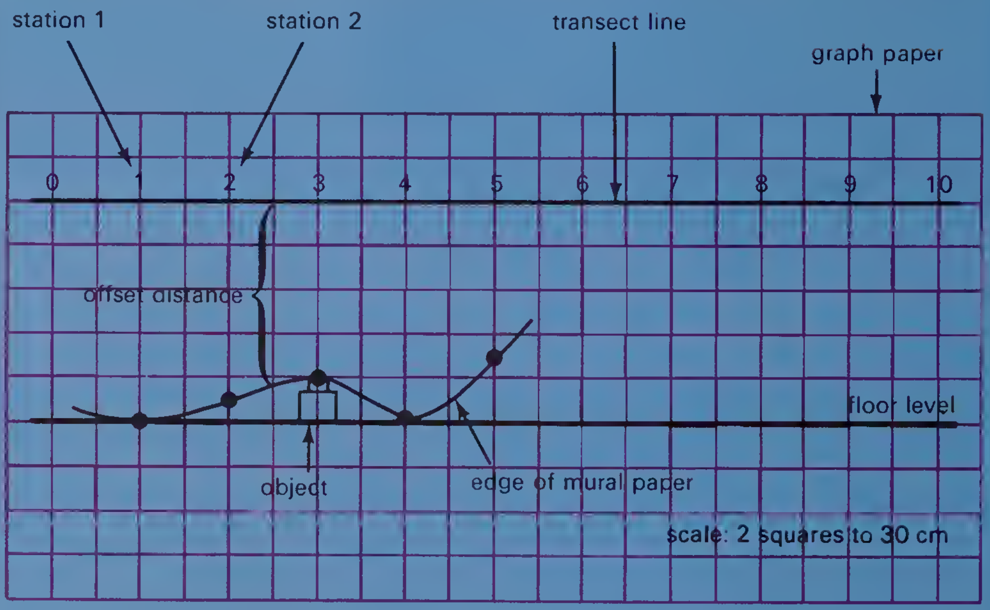
These children are using a plumb line to measure offset distances from a transect line.



Distance along Transect line	Length of Plumb line
30 cm	75 cm
60 cm	68 cm
90 cm	60 cm
120 cm	75 cm
150 cm	42 cm

Make a chart or data sheet, similar to the one shown, on which you can record the measurements that you obtained.

Before plotting the data collected onto graph paper to make your map, some decisions about size or *scale* should be made. Keep in mind that drawing your map to scale simply means that you will have to select some measurement so that the data will fit onto your map paper. The area about which you made your measurements is probably long and narrow in comparison to the area you used when making your floor plan maps. In order to use up more of the graph paper (or to produce a large map that can be more easily seen) one unit may have to represent two, three, or more of the squares.



The information from the data sheet might look like this when plotted on graph paper.

Why should the base line in this map be drawn near the top of the page? When you have found a good place to locate the base line, draw it using a pencil and a ruler. The base line represents the position of your transect line. Mark your starting point as zero and number the units on the appropriate graph paper lines according to your scale. Count the number of units along the base line to locate the point at which the plumb line was used.

Count downwards from the base line to locate an offset distance you measured with the plumb line. Mark this point and repeat the procedure for each distance along the transect line for which you obtained an offset measurement.

Next, connect up the dots with a line that resembles the shape made by the

Using data to draw a cross sectional map.

paper or cloth that was used to cover the objects you placed on the floor.

Finally, add a scale, a title, and a legend to your cross sectional map.

Digging Deeper

Why should the transect string be kept tight?

Why should the level be placed in the center of the transect string?

If the air bubble in the level is to the right of the marks on the tube, which end should be raised? lowered?

Why is it important to attach as light a level as possible to the transect line?

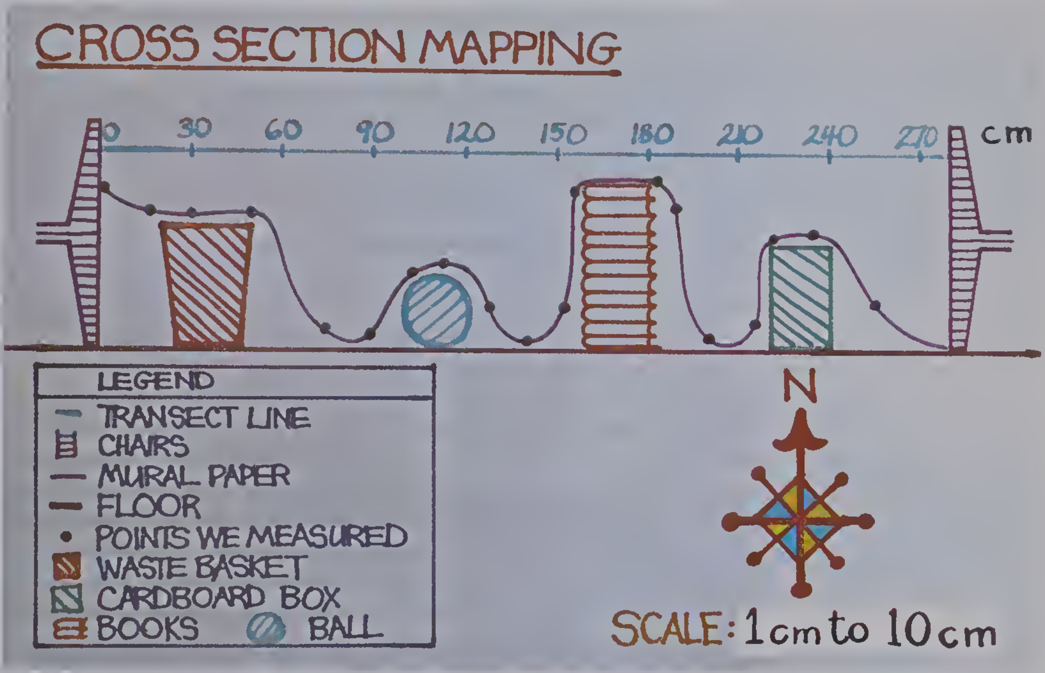
Why can you not trust your eyes alone when you are testing to see if an object is level?

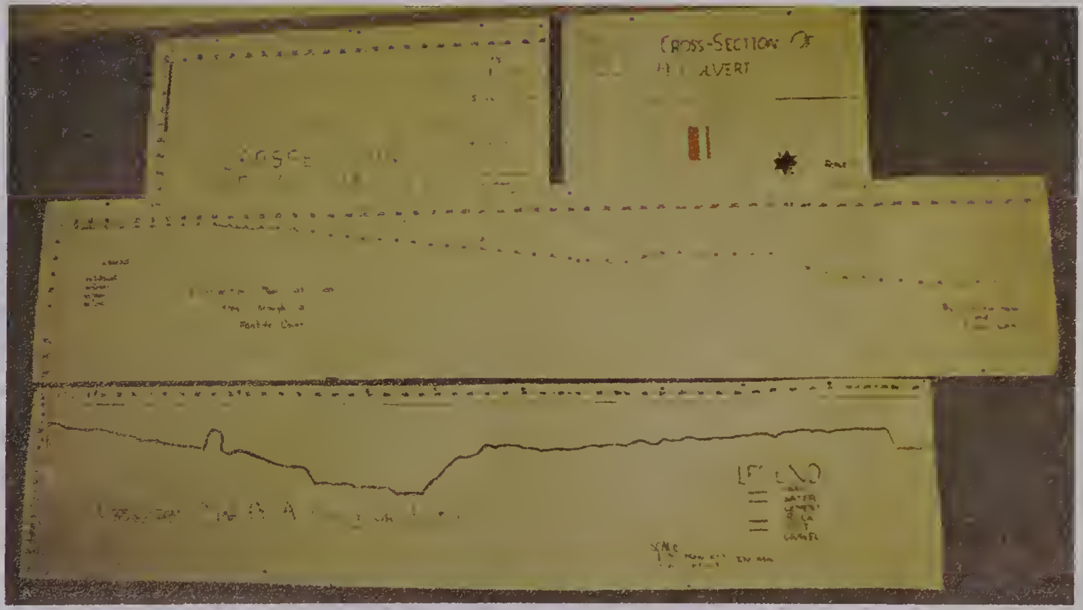
Why should the marks be placed on the tube so that they are the same distance from each end of the tube? What was the purpose of adding food coloring to the water?

Why is alcohol, instead of water, used in store-bought levels?

What name is given to lines that run in the same direction as the horizon? What name is given to lines that run at right angles to the horizon?

A completed cross sectional map.





How would you have improved these cross sectional maps?

How many units should be allowed for the height of the plumb bob on the end of the plumb line?

Why is it important to wait until the plumb bob stops swinging? What are the advantages of using the plumb line instead of the cardboard corner? What are the disadvantages? What keeps the plumb line tight? Under what conditions are your eyes not reliable for judging if an object is plumb?

What would be the advantage of attaching a wire pointer to the bottom of the plumb bob?

Suppose the area of which you were making a cross sectional map was as long as your schoolyard. What units might you let one square of your graph paper represent?

What would the scale of a map be if one square on the graph paper represented three of the units on the transect line?

What would the scale of a map be if three squares of the graph paper represented one unit on the transect line?

If you turned the map upside down and then measured upwards from the base line, would you obtain the same results? Try it.

When working outside, how would stakes driven into the ground have an advantage over the chairs used in the classroom?

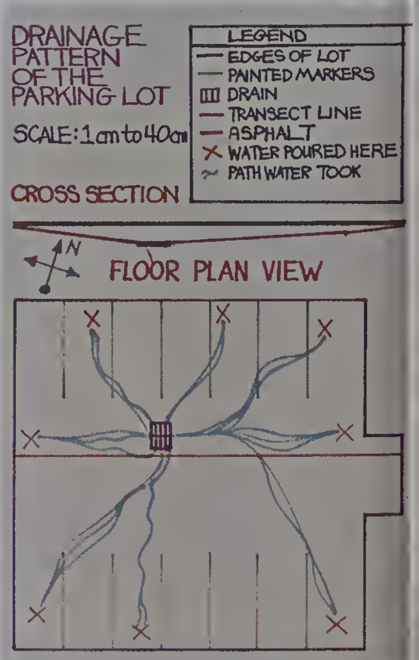
Look up the meaning of the word *profile*. Are cross sectional maps profile maps?

Branching Out

List some things that you think are level such as floors, table tops, window sills, sidewalks, and so on. Test each with your level to see how accurate your judgment was. How could you use a ruler and your level to find out how much to raise one end of an object to make it level?

Locate a drain or sewer grating that is either inside or outside your home or school. Use the level to find ten or more points from where the water will drain toward this opening. Mark these points with chalk. Use the base line and offset process to accurately map the area drained by the water outlet.

How water can be used to study and map a surface.



A plumb line can be used to determine how far off plumb objects are.

On a day when you know it is going to rain, use your level to find places on the paved portion of your driveway or schoolyard where puddles will form. Mark these places with chalk. After it has stopped raining, check to see if you were right.

What objects in the room might be level in one direction but not in another? Test them to see if you were right. What is the least number of times that a level must be used in order to test if a large surface is level?

How could a ball be used to test if a surface is level?

Check the slopes of outside door and window sills. In which direction do they usually slope?

Use your plumb line to investigate walls, poles, tree limbs, and fence posts. Predict which you think are plumb and then test to see if you were right.

How could a ruler and a plumb bob be used to find how much an object is tilted?

Construct an instrument that could be used to see if an object is plumb, as well as level.

How can a carpenter's level be used to measure if a wall is plumb?

Is this pole plumb?

In a large dish pan, use sand to build a model of a landscape containing ravines, hills, plains, and valleys. Use pencils for stakes, string for your transect line, and a thread with a paper clip attached to the end for a plumb line and bob. Level the string by holding the level so that it just touches the string. Sketch what you think the cross section will look like. Map it accurately and compare your results with the sketch. Repeat the activity with the pencils placed in different locations.

How would changing the position of the pencils alter the shape of the cross section?

Activity 2:

How do the heights of plants vary with increasing distance from a fence?

The above question is one that cross sectional maps could help you answer. You will need a measuring string to use as a transect line, a line level, a plumb line, a broomstick, a data sheet, and a hammer.

Find a fence that has some interesting plants growing beside it. Attach one end of your transect line to the fence, about one metre above ground level. Use the hammer to drive the broomstick into the ground about two metres out from the fence. Attach the other end of the transect line to the broomstick. The transect line should be perpendicular to the fence. If it is not, untie the transect line at the fence, move the line so that it makes a right angle with the fence, and then retie it to the fence. Use your line level and slide the knot on the broomstick up or down until the line is level.

Next, use your plumb line to measure the distance from the transect line to the tops of plants directly under the transect line. Take plumb line measurements along the transect line at intervals of 10 cm. It is not necessary to measure to the top of every plant. Also record the distance from the transect line to the surface of the ground at regular intervals. It might be helpful to trace the leaf of each plant for which you took a measurement, in order to keep track of the various types of plants.

Will the same type of plant be found at the same distance from the fence at other places along the fence?

Repeat the activity at different locations along the fence as well as along other fences.

Draw a cross sectional map for each location of your transect line. Show the surface of the ground. Draw a vertical line to represent the height of each plant. Add a leaf tracing or a symbol to show the type of plant each line represents.

Digging Deeper

Why should the transect line be about the same height above ground at each location that you selected along the fence?

How could the height of plants growing above the transect line be shown?

What does the fence represent when several cross sections are measured from it?

How could you calculate the height of the plants from the data which you collected?

How could the map itself be used to find plant heights?

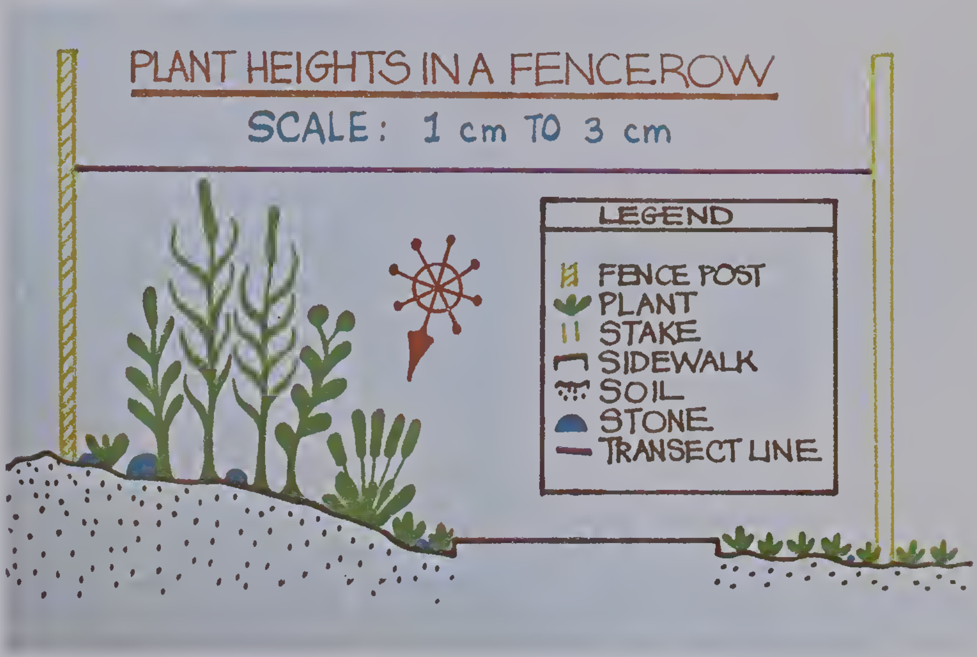
What was the height of the tallest plant? the shortest plant?

How far from the fence was the tallest plant growing?

How often did you find the same type of plant growing at about the same distance from the fence?

How often were the same types of plants found to be the same height?

How far from the fence is the tallest plant? Are the tall plants usually the same species?



What is the connection, if any, between plant height, type of plant, and distance from the fence? What factors affect the height of plants living in this environment?

Branching Out

Ask your teacher to take your class on a field trip to study a stream. Make cross sectional measurements at interesting places along the stream bed. Include such features as plant life, depth of the water, size of rock particles on the bottom, evidence of animal life, and presence of islands, sand bars, and logs. What equipment will be needed to carry out this activity?

When you return to your classroom, use the measurements you recorded to draw cross sectional maps. Make a papier-mâché model of the stream bed.

An ant hill similar to ones you could map.

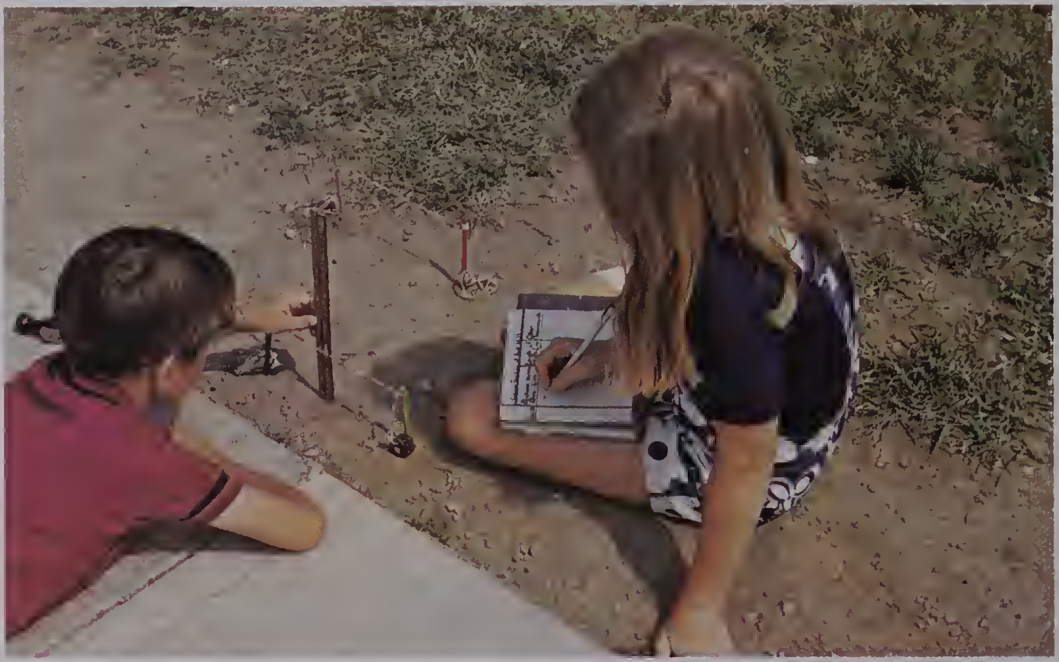
Activity 3:

How does the size and shape of an ant hill change from day to day?

Find an ant hill that is in a protected location where no one is likely to step on it or disturb it. Sandy soil beside a building or in a garden is a likely place for ant hills. Set up a miniature transect line over the ant hill using two sticks and a piece of string that has been marked off in 2 cm lengths. Lie down so that the transect line is at eye level. Use a ruler to carefully measure the distance from the transect line to the ground at each mark along the line.

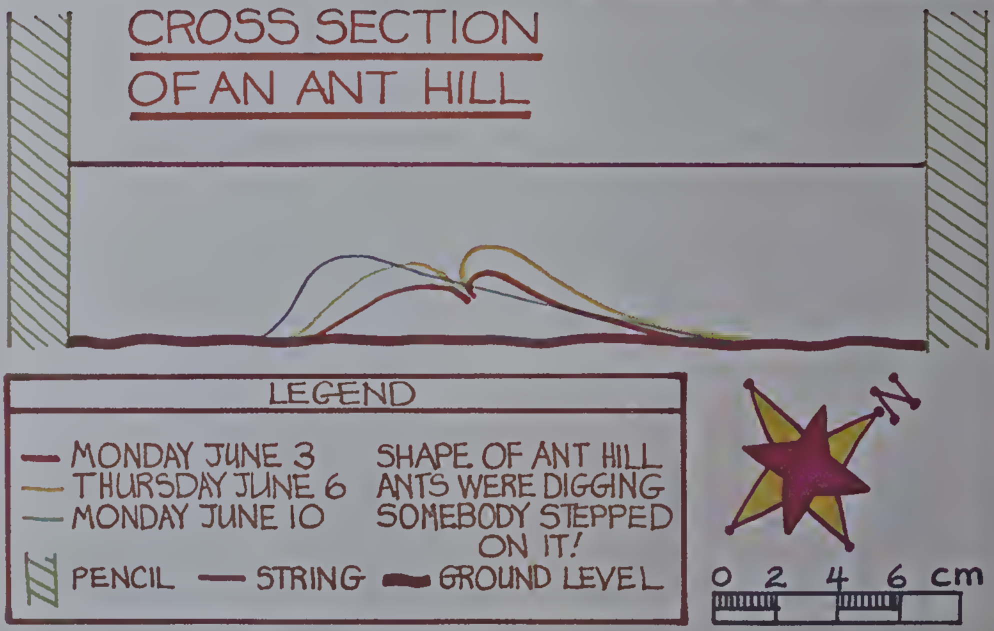
Leave the sticks in the ground. Return to the ant hill every second day for ten days and make new measurements.

Draw each cross section on the same map, but use a different color each time. Show the date for each color in your legend.



Why is this a poor location for mapping the changes in an ant hill?

Why were several sets of data placed on this map?



Digging Deeper

Why was it important to place your transect line in exactly the same place each time?

Why was a ruler used in place of a plumb bob?

What type of scale could you use when drawing your map in order to enlarge the size of the ant hill?

On which days did the ant hill become larger? What might account for this change in size?

What weather conditions might cause the ant hill to become smaller? List as many other factors as you can that might affect the size of an ant hill.

What might account for an ant hill being higher on one side than on the other?

How can you tell if the ant hill is old or new?

Are all ant hills the same shape in cross section?

What type of mapping method would you use to show changes in the size of the surface area of the ant hill?

What would account for the changes that would occur in a sand pile similar to this one?

Branching Out

HOW DOES THE SURFACE OF A SAND PILE CHANGE FROM DAY TO DAY?

How would you investigate this problem? List the steps you would follow and then match your list with the steps shown in the photographs.

Collecting data for a cross sectional map of a puddle.

Activity 4:

How can you map the cross section of a muddy puddle?

After a rainstorm, look for a puddle so muddy that you cannot see the surface covered by the puddle. How could you measure how deep it is? One method involves the use of several drinking straws, two bricks or rocks, and a piece of string marked off in 2 cm lengths.

Stretch the string across the puddle and use a brick or a rock at each end to keep the string straight and out of the water. You could use a metre stick in place of the string if the puddle is not too wide.

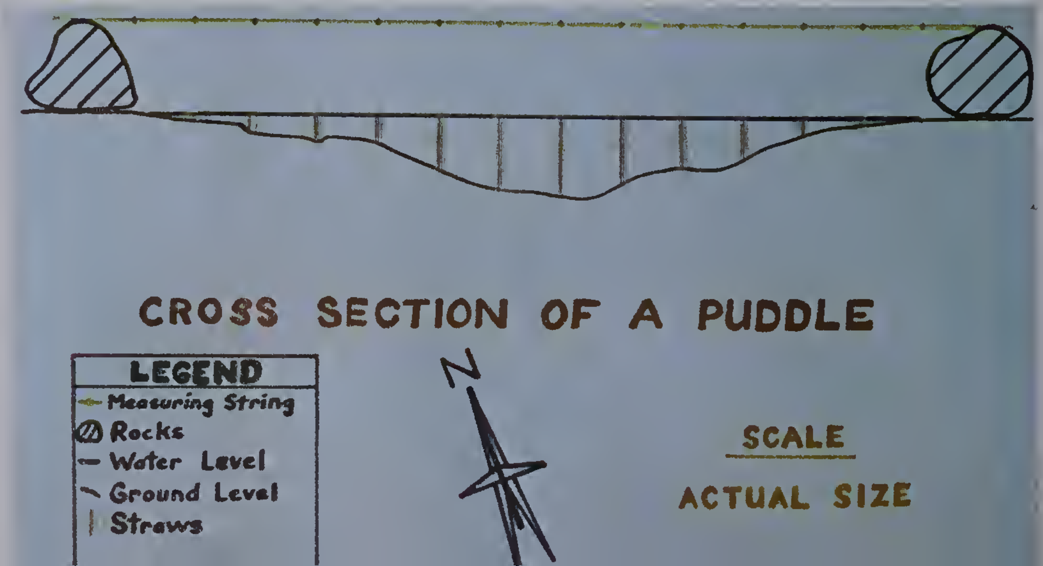
Begin at one edge of the puddle right beside the string. Carefully lower a straw into the puddle until you feel it touch bottom. Use a pencil to mark the water level on the side of the straw. Cut off the straw at this point with scissors and mark the part that was in the water with the numeral "1".

Repeat the process at regular intervals along the string. Be sure to number and keep the part of each straw that you use which was under water. Mark the second straw with the numeral "2", and so on.

Place a piece of wood, large enough to float a line level, on the surface of the puddle. Put the level on the piece of wood and determine if the surface of the water is level. Be sure that the position of the level is not causing the block to tip to one side.

When you return to the classroom to make your map, obtain a large sheet of paper. Draw a line which exactly matches the width of the puddle at the place where you put the string. Divide this line into the same intervals you used when measuring the puddle. Glue the pieces of straw that were in the water onto the paper so that the cut end of each straw touches the line and is perpendicular to it. Each straw should be located at the same place in which it was used at the puddle. All the straws should be below the line. Join up the bottom of each straw with a smoothly curving line. This line will represent the bottom of the puddle.

Where were the straws used in this cross sectional map of a puddle?



Digging Deeper

What was used as a base line in place of the transect line?

What was the purpose of the string?

Why should the straw be lowered into the water so that it is straight up and down?

What changes would be produced in the cross section if the string had been placed in another location over the puddle?

How could you design a data sheet that would help you to remember the correct distance along the base line for each straw?

What were the advantages of using a straw, instead of a plumb line, in this activity?

What would be the disadvantages of trying the straw method for very large or very deep puddles?

Branching Out

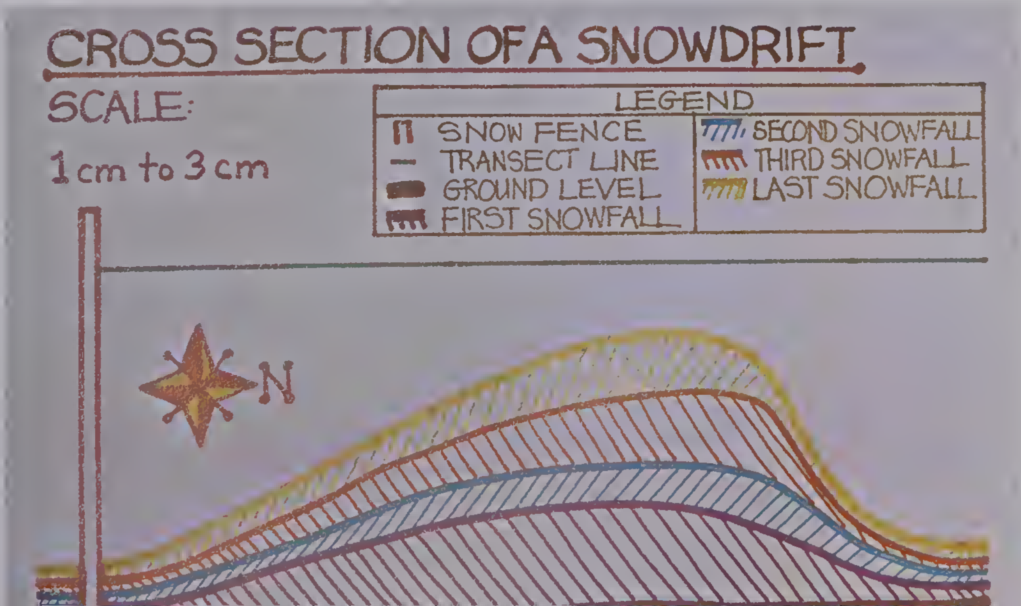
HOW CAN THE CROSS SECTION OF A SNOWDRIFT BE MAPPED?

Find several interesting snowdrifts!

Set up a transect line running across one of the snowdrifts and attached to two broom handles planted in the snow. Use a plumb line to measure the surface of the snowdrift. Insert a metre stick into the snowdrift at the same locations as you used your plumb line. By measuring the depth of the drift, you will be able to locate the ground level. Measure several snowdrifts in this manner. Draw the cross sections and then compare them.

Measuring the cross section of a snowdrift.

Would all snowdrift cross sections be like the one shown in this map?



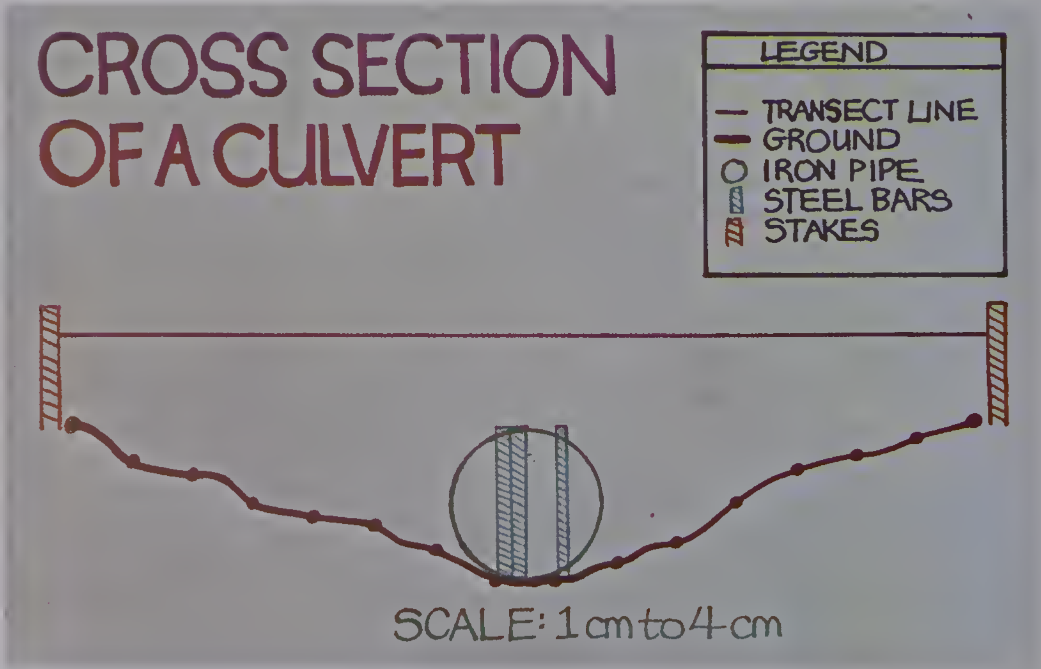
In what other investigations would a cross sectional map be useful?

Find other areas such as ditches, gardens, slopes, steps, erosion gullies, or animal burrows, which you think might make interesting cross sectional maps.

Examine various blueprints. Which portions are cross sections? How are parts that are inside other parts shown?

Do some research in your library to discover how the bottom of the ocean is mapped.

Some other interes ing locations wher cross sectional map could be made.



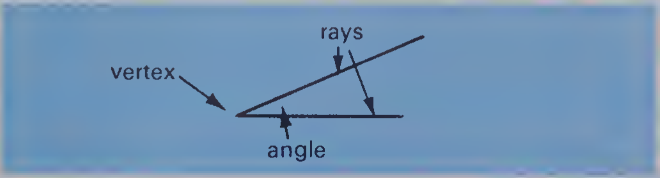
Angles On The Ground

4. Angles On The Ground

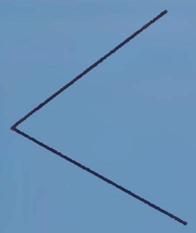
When surveying larger areas such as your schoolyard or a vacant lot, the base line and offset method often can be too slow. How would you map the heights of objects such as buildings or trees that were separated from you by a high fence? To help solve such problems, surveyors measure angles as well as distances. In order to make maps using angles you will need to learn about angles and protractors.

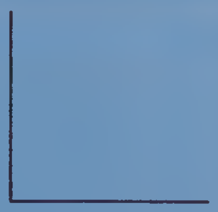
Angles

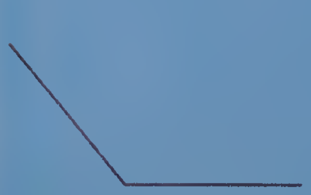
Use a ruler and pencil to draw two straight lines that just touch each other. The straight lines are called *rays*. The point where the rays touch is called the *vertex*. The two rays form an *angle* at the vertex.

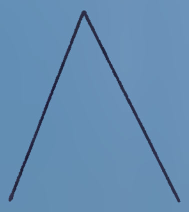


To which of the angles shown is your angle most similar?

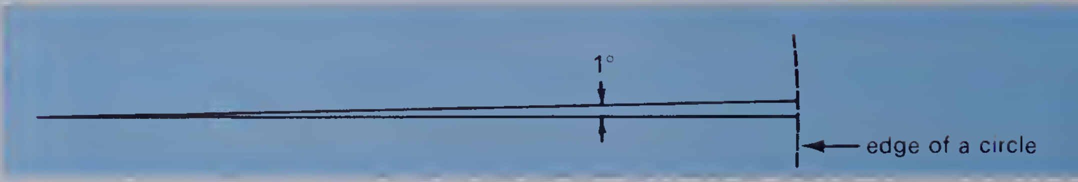




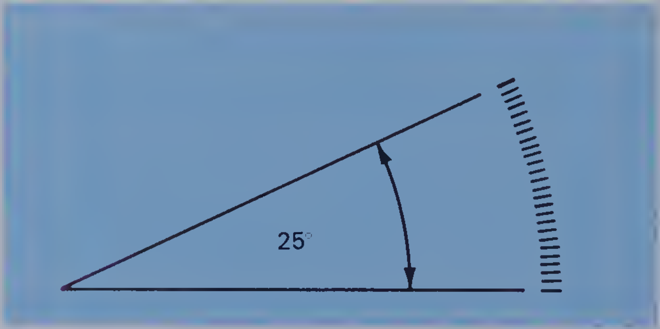




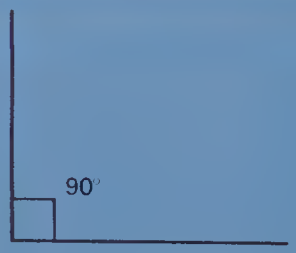
You can divide circles into angles in much the same way as you would cut a pie into equal portions. A circle can be cut into angles by drawing two straight lines through the center and crossing the circle's edge. Mathematicians divide circles into 360 equal sections. Each of these long and narrow "pieces" of the circle is said to have one *degree* between its rays. Each of the 360 equal sections of the circle contains this angle of one degree.



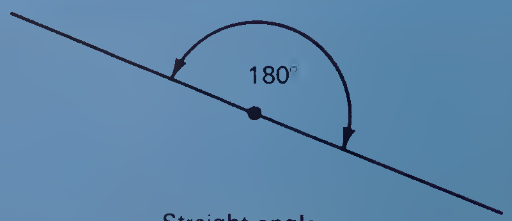
The symbol for degree is a small circle. For example, twenty-five degrees is shown as 25°. An angle of twenty-five degrees is the same as a 25° angle.



Some angles are given names. A 90° angle is called a right-angle and an angle of 180° is called a straight angle.

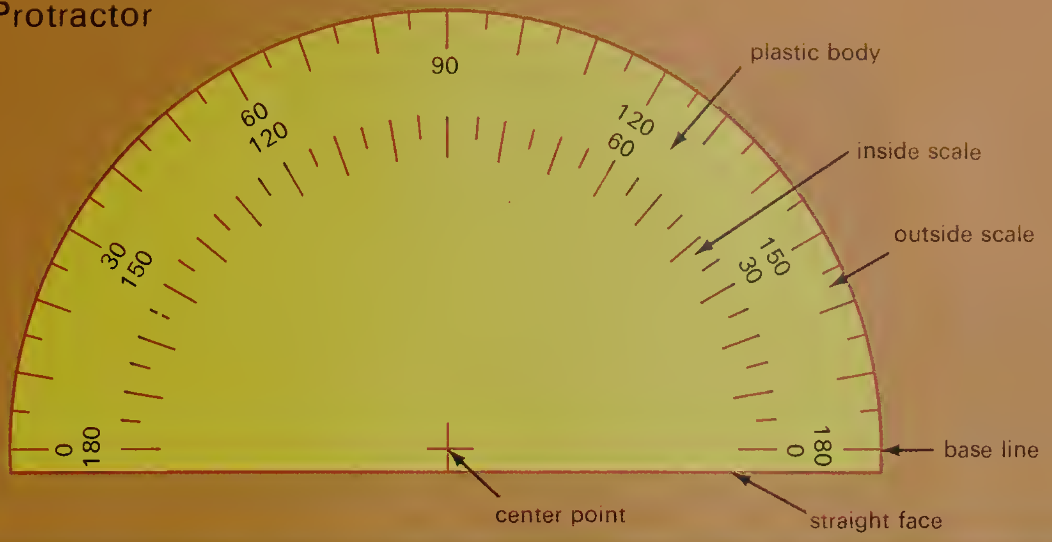


Right angle



Straight angle

A 180° Protractor



Activity 1(a):

How is a protractor used to measure an angle?

One type of instrument used to measure angles is called a *protractor*. Some protractors are shaped like half circles and are divided into 180°; others are full circles and contain 360°. The degrees are usually numbered starting from either end so that the angles can be read in either direction.

The numbers and markings make up what is called the scale. Protractors can be used both to find the number of degrees in an angle and also to make an angle of a certain number of degrees.

Obtain a 180° protractor, or trace one from the pattern shown.

Place the center point of the protractor over the vertex of the angle.

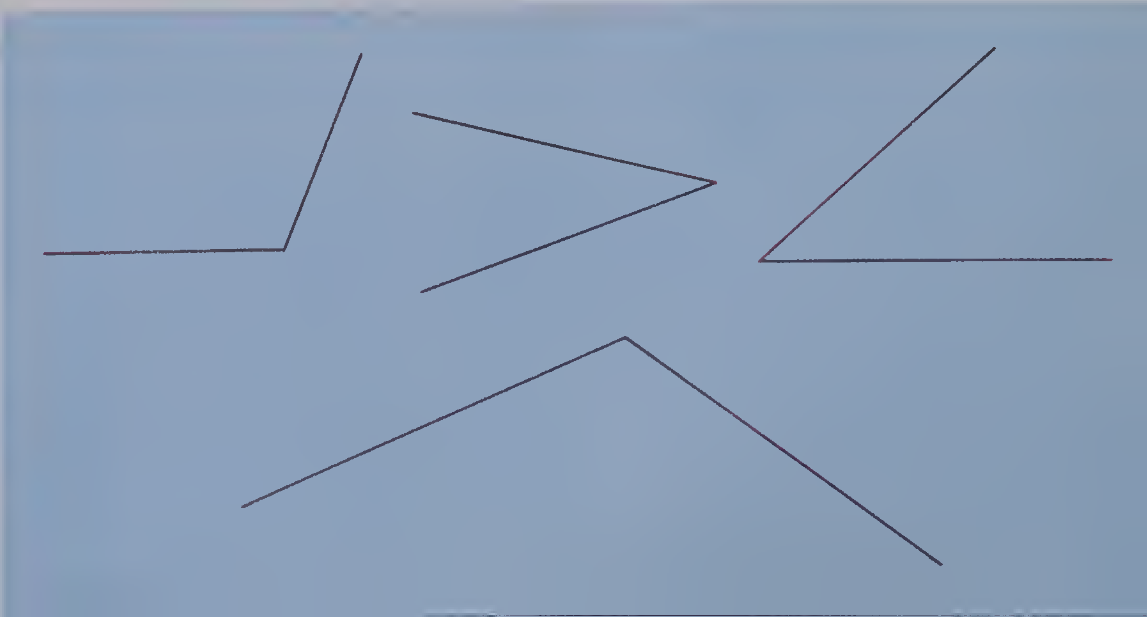
Keeping the center point on the vertex, turn the protractor so that the base line covers one ray of the angle. If the other ray is below the base line, turn the protractor so that this ray is covered by the base line.

Now you are ready to determine the size of the angle. Use the scale that reads 0 for the ray under the base line, and take the reading for the other ray of the angle. This value gives you the size of the angle in question.

How is the protractor being used to measure this angle?

Check the position of the protractor. The zero mark on the scale must always be at the base line. On some protractors the zero mark is slightly above the straight edge.

Use a protractor to measure these angles:



Measure some objects in your house that you think have right angles. What type of protractor would be the best type to measure an angle of 195°? How would you measure one half of a degree on a protractor? What would a 360° angle look like?
Which doors in your house will open less than 90°? exactly 90°? more than 90°? Ask an adult or a fellow student to verify your results.

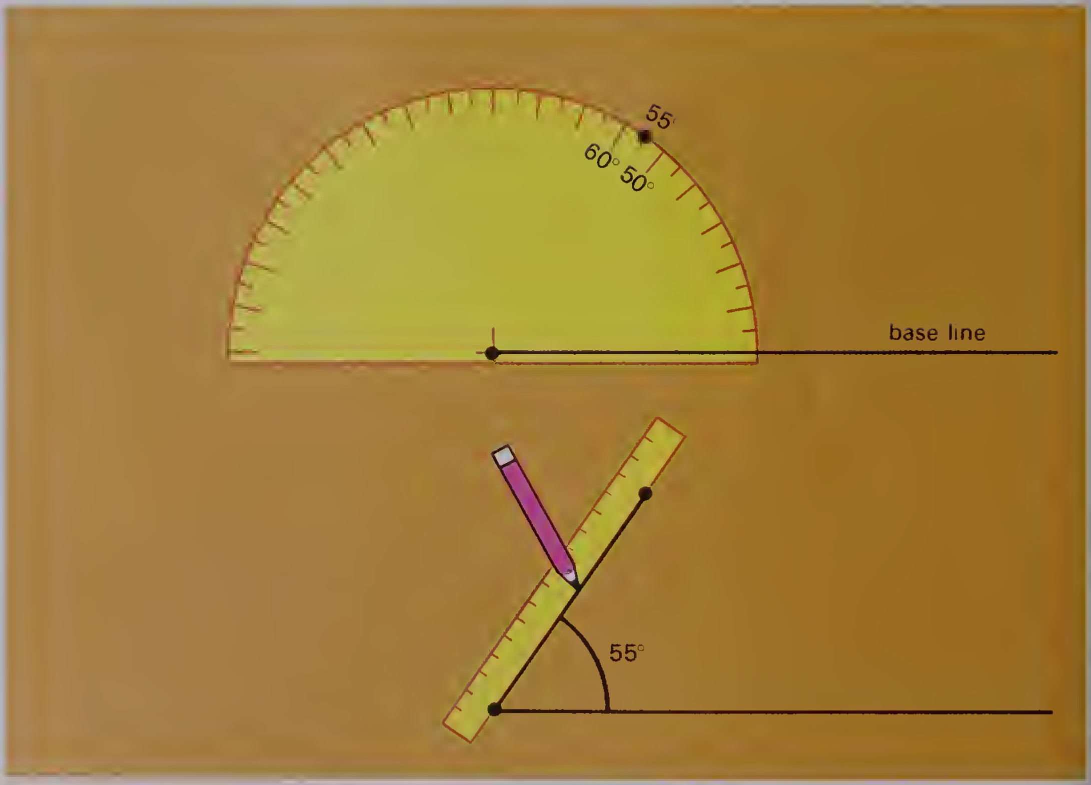
Activity 1(b):

How can a protractor be used to make a particular angle?

Choose an angle between 0° and 180° which you would like to make. Use your ruler to draw a straight line. This line will form one ray of your angle. Put a dot at one end of this line. The dot will be the vertex of your angle.
Place the base line of the protractor along this line so that the center point is over the dot. Check to see that the 0° mark is on the line.
Find on the scale the number of degrees required for your angle. Be careful to use the correct scale.

Put a pencil mark on the paper beside the angle reading on the scale.
Use a ruler to draw a straight line from the dot on the straight line to the mark you made. This line forms the second ray and completes the drawing of your angle.

Where should the center point of the protractor be placed to measure the angle formed by the corner of the desk?

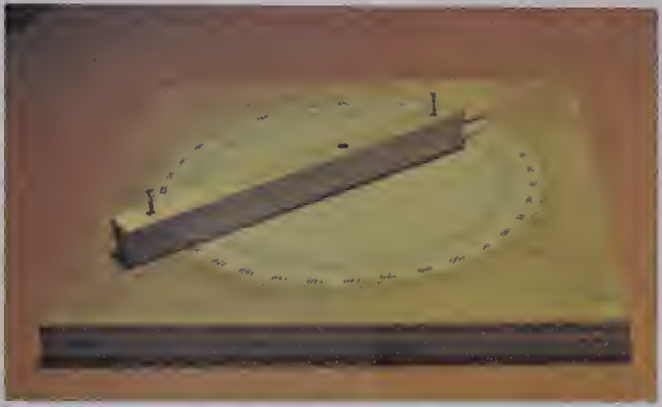


Digging Deeper

Try to construct the following angles: 45°, 5°, 150°, 90°, 60°, 180°. Check the accuracy of your measurements by having an adult measure the angles for you.
Draw an angle of 270°. What other angle does it resemble?
Compare a 360° protractor and a compass rose. How many degrees are found on each? How many degrees correspond to NE? SE? NW? SW? What

Can you change each of the points of the compass into degrees?

A completed transit.



direction would correspond to 0°? 180°? 90°? 270°? Do the degrees read in the same or the opposite direction to the numbers on a clock? A clock face is usually a circle. Why was it not divided into 360°?

Activity 2(a):

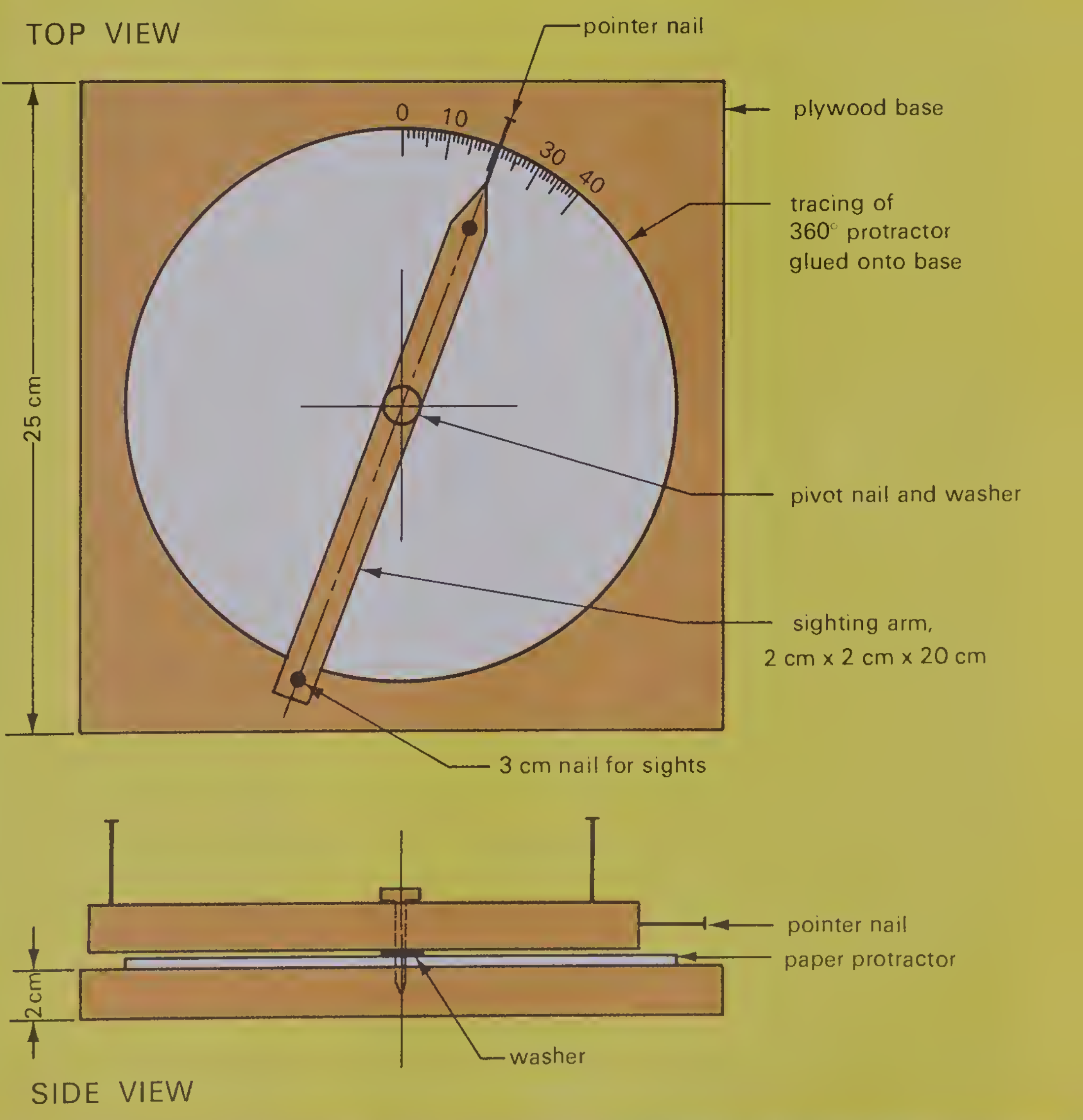
How can angles in your schoolyard be measured?

A *transit* is the name given by surveyors to the instrument they often use to measure angles. To make a transit, you will need the following materials:

- a piece of plywood, 2 cm thick and at least 25 cm square, for the base;
- a 360° protractor traced from the pattern on page 101;
- a piece of wood, approximately 2 cm wide, 2 cm thick, and 20 cm long;
- four finishing nails, 3 cm long;
- a metal washer;
- white glue;
- a hammer.

Use the plans and photographs to help you put the transit together.

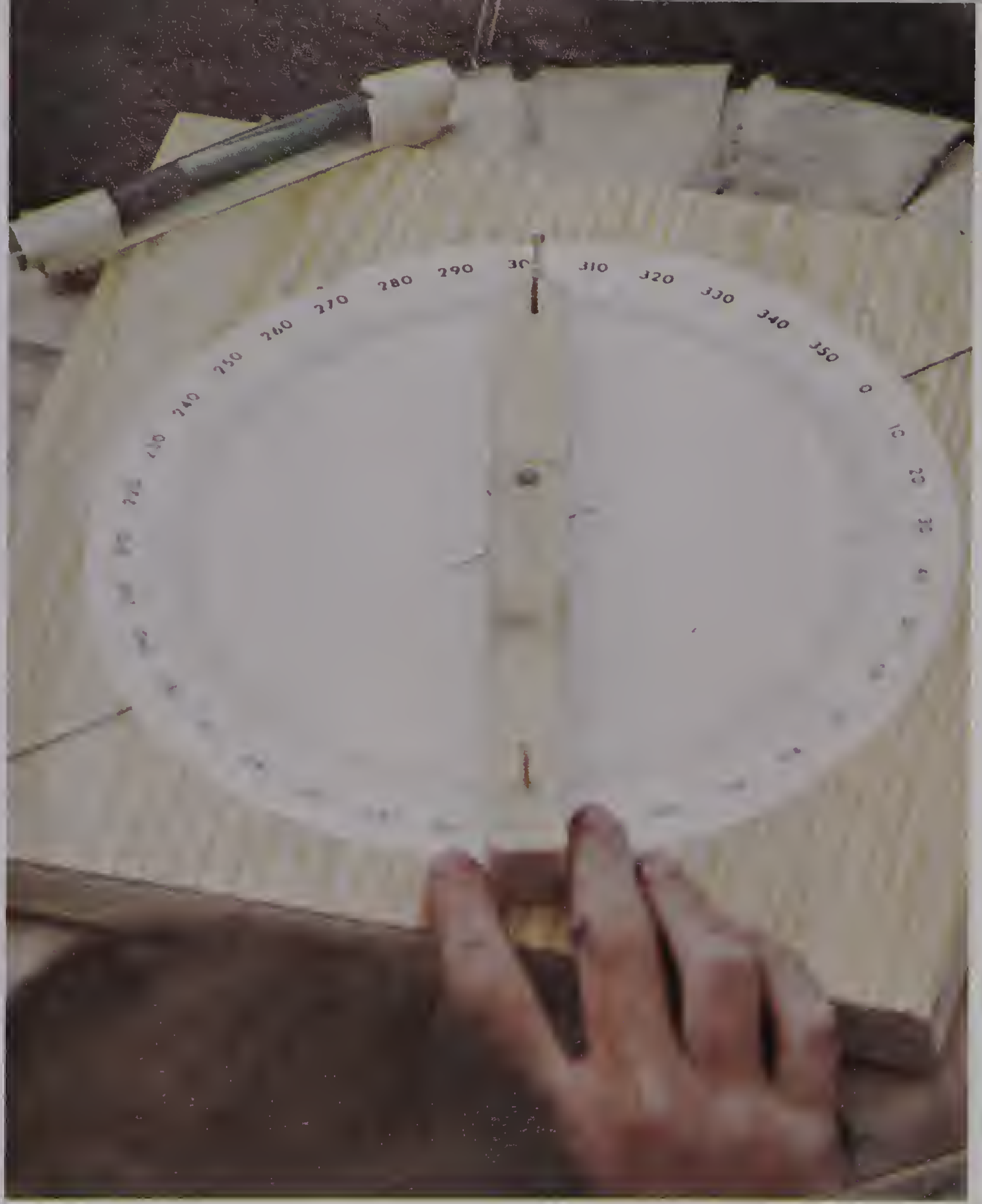
A Simple Transit



What angle was measured in these photographs?

Various ways to mount your transit.

Obtain a cardboard box, an overturned waste basket, or some other object with a raised flat surface that could be used as a stand for your transit.



Go outside and select two objects such as the flagpole and a corner of the school building. Set up the transit and stand so that imaginary lines from the objects meet at the transit and form an angle.

Turn the pointer arm so that its nail is in line with the zero of the protractor scale. Turn the base so that the sights line up with the first object you selected.

Turn the pointer arm so that the sights line up with the second object selected. Be careful not to turn the base of the transit. Read the number of degrees under the pointer nail. This is the size of the angle between the two objects.

Digging Deeper

Why should the surface on which the transit is placed be as level as possible? Measure an angle with a transit that is level; then try holding the transit on a slant and remeasuring the angle. Compare the two measurements.

What angle would be measured if you set your scale at zero for the second object and then sighted back to the first object?

If you were sighting at a very wide tree trunk with your transit, on what part of the tree trunk would you line up your transit sights?

Would you obtain the same results using your right eye for sighting as you would if your left eye was used?

How could a circular protractor with two scales be used on a transit?

If the circular protractor on a transit has only one scale, in which direction should the sighting arm be turned?

Branching Out

How do the angles between objects change if the position of the transit is changed?

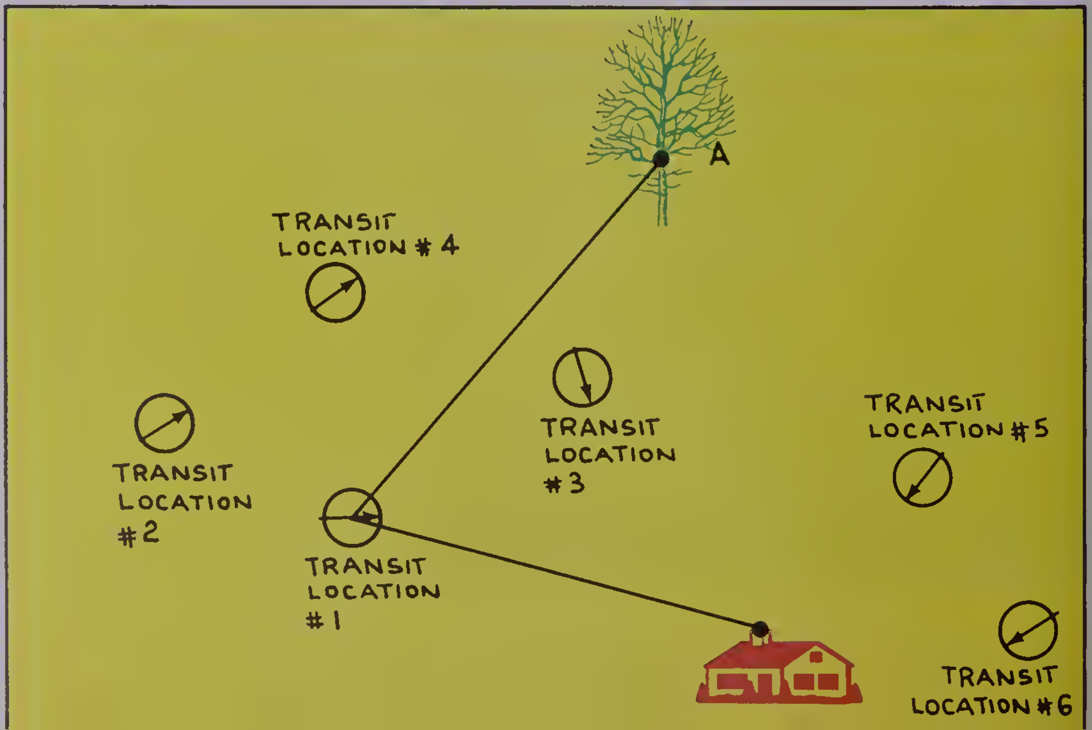
Where would a transit have to be located between two landmarks in order to measure an angle of 90°? Try to locate this point by moving the transit to several locations.

Measure the angle between two objects. Mark the point at which the transit was located with a stick. Move the transit closer to one of the objects. Predict whether the angle will be larger or smaller. Measure to see if you were right. Move the transit back 50 cm or so from where your first measurement was made. Predict and check the changes in angle size that will occur. Try moving the transit to each side of your original position. What happens to the angle in each case? How is your ability to predict angles improving?

Select a fence row that has at least six or seven fence posts in a straight line. Set up the transit so that you can measure the angle between the two fence posts that are nearest to you. Es-

Is the angle between the center post and the left post the same as that between the center post and right post?

How would the angle between A and B change for each location of the transit? Use a protractor to check these angles.



timate what you think the angle would be between each of the other posts, and then measure them with your transit. How could you build a better stand for your transit? Try to design and construct a stand that would have these features:

tall enough to be used when you stand up;
folds up for easy storage;
sturdy enough not to move when the sighting arm is turned;
allows the transit to be taken off and replaced easily;
easy to level.

Activity 2(b):

How can you collect data for a map using a transit?

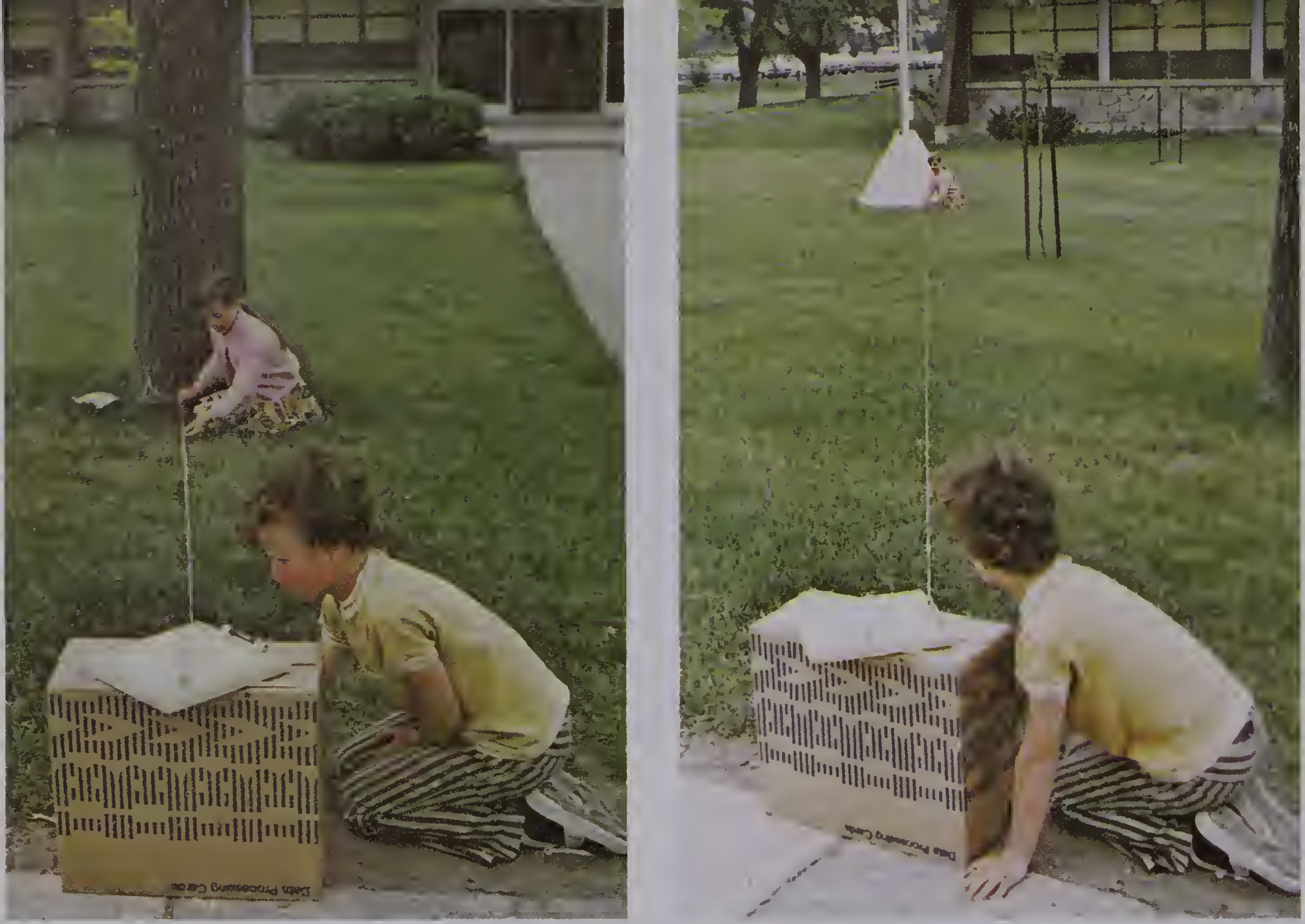
Choose an area near your school that you wish to study. Make a quick sketch of the area. This drawing will serve as your data sheet.

Select and set up a good base line. Place the transit on this line so that the pivot nail is directly over the line. Mark the location of the base line and transit on the sketch.

How would moving the transit change the angle between fence posts?

The area to be mapped.

Set the base of the transit so that the zero of the scale is on the base line. Now follow the necessary steps for measuring the angles to the objects that are to appear on your map.



Distances from the transit to objects are being measured.

Draw and label the number of degrees on your sketch for each angle that you measure.

Use your measuring string to find the distance from each object to the transit. Record each distance on your sketch.

Digging Deeper

In the diagram why is it a good idea to use broken lines to join the transit to the object? Why is a curved arrow used to show where an angle is measured? On which end of the curved line should the arrowhead be placed? Where could a measurement be written in order to show that it belonged to a particular line?

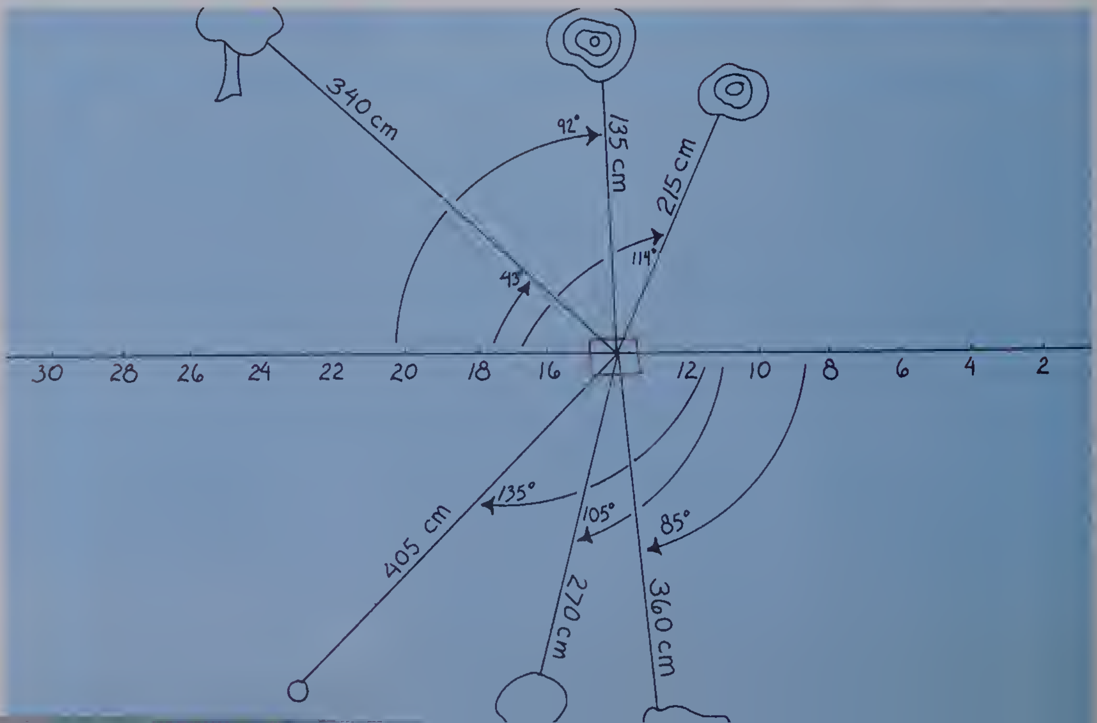
What measurements could be added to a sketch map without having to use the transit to find an angle? How could a plumb line be used to more accurately locate the center of the transit over the starting point on the base line?

Where would the level have to be placed on the transit to be sure that the transit was absolutely level?

What would be the advantages and disadvantages of locating a base line or starting point near the center of the area to be mapped when using a transit?

How would you locate the transit in order to find the angle between two fences or boundaries?

A sketch showing data obtained using a transit and a measuring string.



If an artificial base line is being used, what information should be recorded about it?

How many angles and distances would be needed in order to accurately locate the wall of a building?

What steps would have to be taken if the transit was moved to another point on the base line? When might moving the transit to another place on the base line be necessary? How could you be sure that you could find this new point again if you needed it?

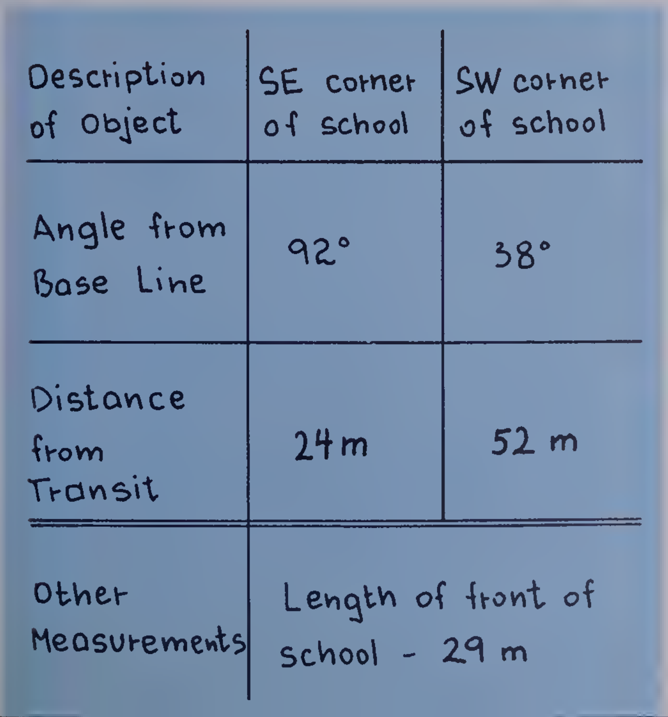
What advantages and disadvantages does the transit and distance method have over the base line and offset method?

Branching Out

How could a chart be used as a data sheet instead of using a sketch?

The chart headings might be as shown in the diagram.

What advantages would a chart have over a sketch? What would be the disadvantages?



Description of Object	SE corner of school	SW corner of school
Angle from Base Line	92°	38°
Distance from Transit	24 m	52 m
Other Measurements	Length of front of school - 29 m	

Can you think of another method of recording data from which maps could be made?

If you have to choose from among several recording methods, what things should influence your choice?

The zero of the transit scale could have been oriented to the north instead of to the base line. What would be the disadvantage of using this method? Under what conditions would orienting the zero point to the north be an advantage?

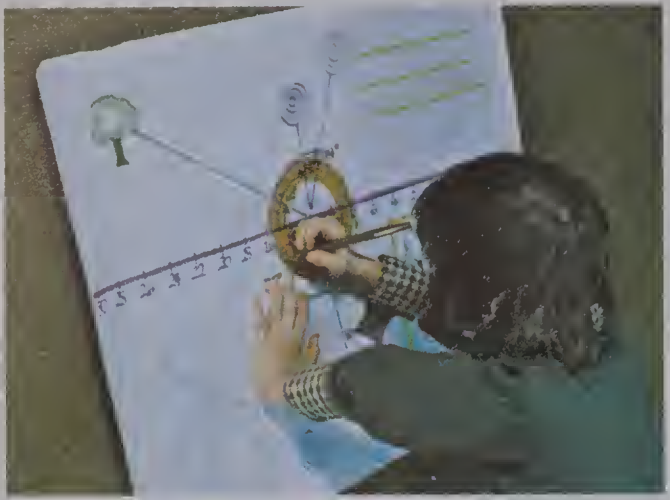
Activity 2(c):

How can you draw a detailed map from the data collected?

Draw the base line on your paper in the same position as the real base line on the ground.

Select a suitable scale so that the longest distance measured can fit on your map. Use the scale to divide up the base line and locate the point at which the transit was set up.

Drawing the base line and locating the points at which the transit was set up.

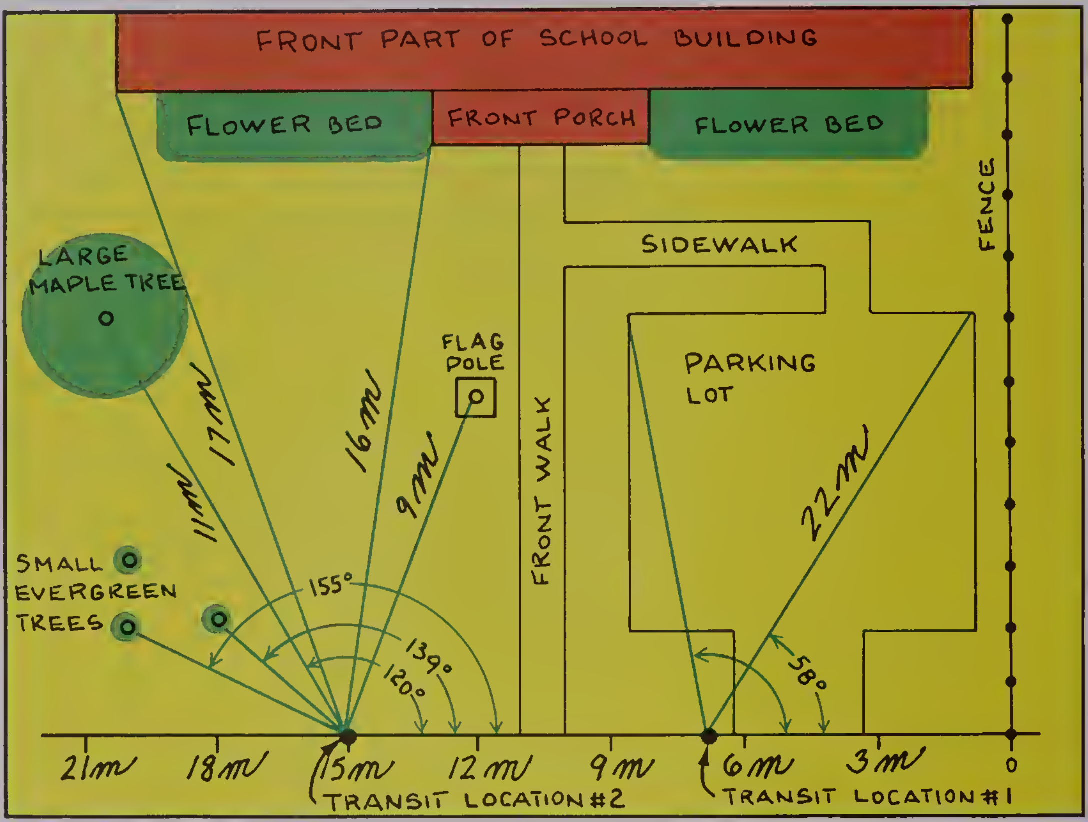


Use a protractor at this point in order to draw one of the angles measured with your transit. Use a ruler and your scale to extend the ray of this angle the correct distance to the object. Do this for each object recorded on your sketch.

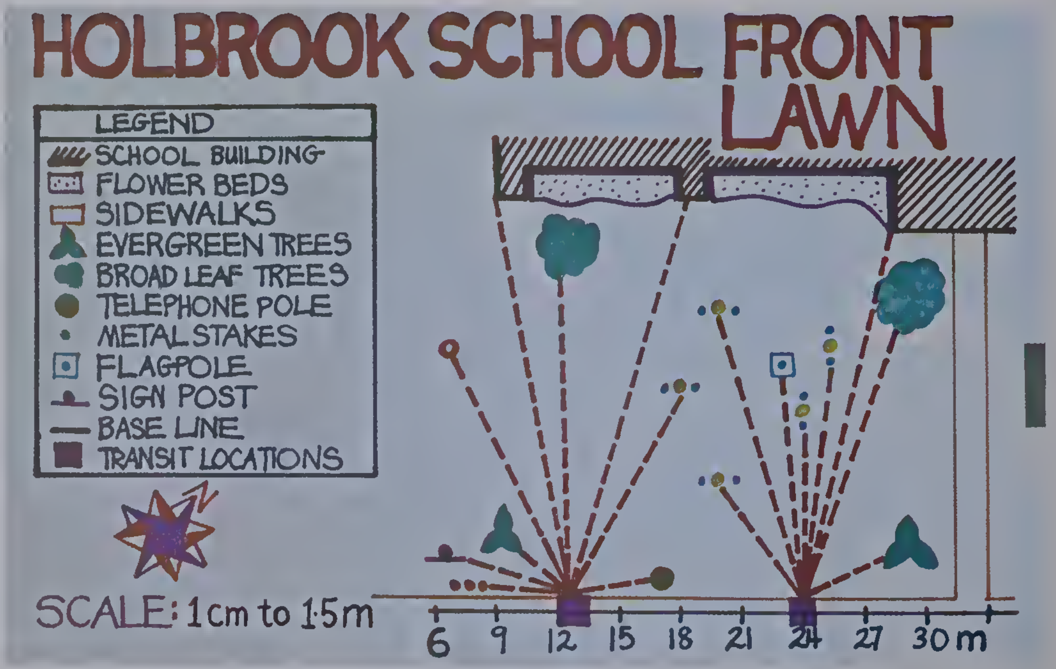
Measuring distances along the rays of the angles according to the sketch.

Draw the symbol that will represent each object or landmark in its proper location. Finally add the legend, title, scale, compass rose, and other parts your map needs.

Why were two transit locations used to gather the data for this sketch?



This map was made by measuring angles and distances. How is this map different from one made by the base line and offset method?



Digging Deeper

What parts of your map could be emphasized with magic marker or crayons? What areas could be filled in with poster paint or pencil crayon?

How could you use different colors to make your map appear more interesting? How could color have been used to make the information stand out more clearly? What should be erased when the drawing of the map is complete?

Branching Out

IS THERE A PATTERN TO THE LOCATION OF THE DRAINS, POLES, AND WATER VALVES ON YOUR STREET?

Caution: If you live on a busy street try to find a quiet street for this study. Ask one of your classmates to act as lookout for cars and trucks.

Make a map of the road and sidewalk portion of the block on which your house or school is located. Set up the transit near the sidewalk in the middle of the block. Use the edge of the sidewalk as your base line. Be sure that you have a clear view both up and down the street. Ask a friend to hold a broom handle or hockey stick straight up and down on the centers of manhole covers, drains, and other objects in the pavement. Measure the angle from the base line to these objects and to telephone poles, hydrants, street lights, and other interesting things you find. Locate the position of the curbs, the gutters, the crown of the road, and the edges of the sidewalks. Pace off the distance from each of these objects to the transit. Use this information to construct an accurate map of a portion of the street.

When your map is completed, use a tape measure to help you check its accuracy, by actually measuring some of the real distances you drew to scale.

If your transit measured an angle of 220° but your protractor only has 180°, how could you draw a 220° angle? Try to think of at least three different ways and then try them.

Activity 3:

How can you find the distance to a telephone pole on the other side of the street without crossing the street?

One method that can be used is called *triangulation* (try-ang-you-lay-shun). This method involves the measuring of one side and two angles of a triangle.

Select a part of the sidewalk on your side of the street for a base line. The base line should be at least 15 m long. Mark the ends of the base line clearly and measure its length accurately. This line will be the base for a large triangle.

Place your transit so that the pivot nail is right over one end of the base line. Turn the base of the transit so that the zero mark on the scale is directly over the base line. Measure the angle from the base line to the telephone pole.

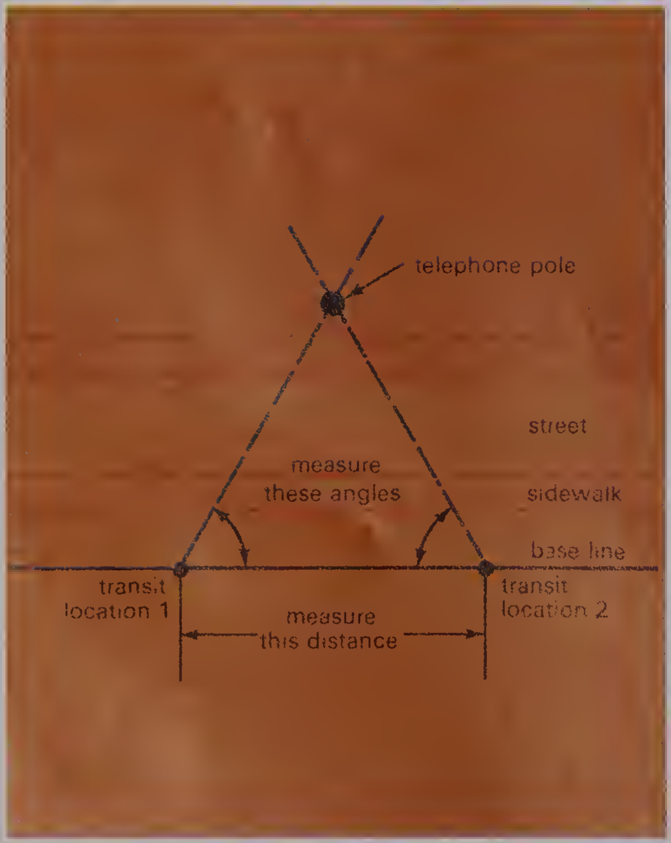
Place the transit over the other end of the base line. Center the pivot nail and set the zero on the scale over the base

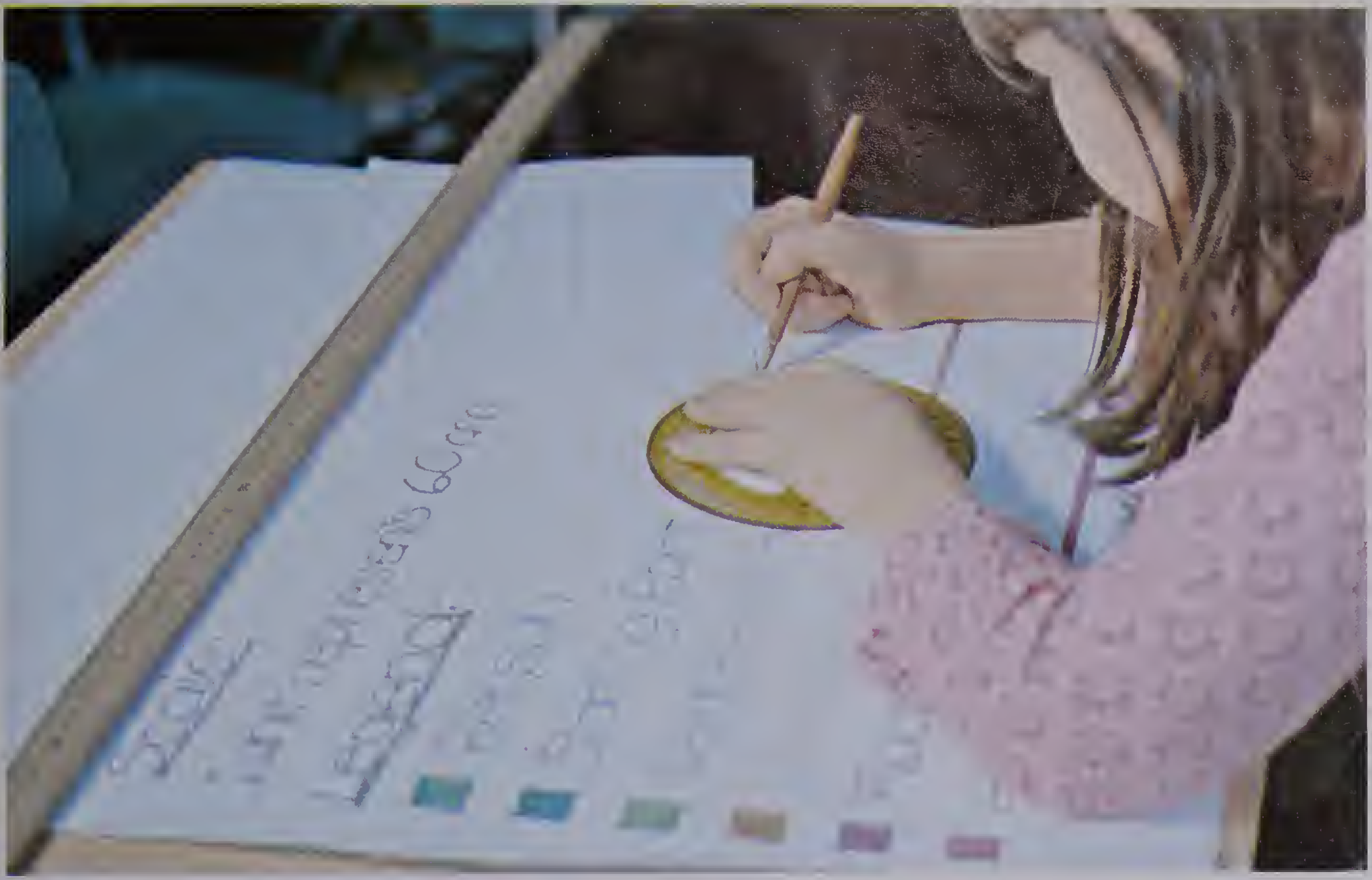
Measuring the distance to a pole across the street.

line again. Measure the angle between the base line and the telephone pole from this position.

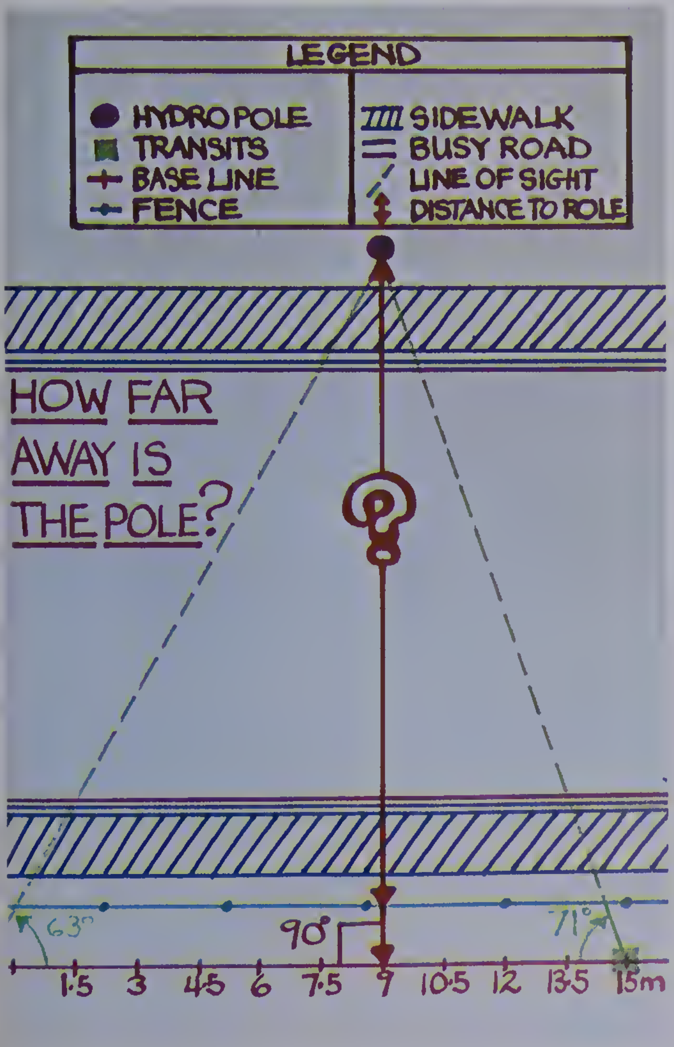
Record the length of the base line and the two angles on a sketch.

Decide on a scale that could be used to draw your base line on a map. Use a protractor and draw the two angles you measured at the ends of the base line on your map. Extend the rays of the angles





The distance to the pole can be found by the use of a scale drawing.



until they cross each other so that a triangle is formed. Use a ruler to find the length of each side of the triangle. Use the scale to determine the real distances for these lines. The ruler and scale can also be used to measure the distance to the pole from any point along the base line.

Digging Deeper

How could you find the shortest distance from the base line to the object?

The three angles of a triangle always add up to a total of 180°. How could this information be used to check the accuracy of your triangulation?

How would moving the base line farther up or down the street change the angles and the lengths of the sides of the triangle?

What would the angles and distances be if the base line was twice as long as the one you used?

Why should a base line only 1 m in length not be used in this activity?

Branching Out

Use triangulation to find out how far away some distant objects such as chimneys or antennae are.

Read to learn how astronomers find the distance to the moon and stars.

Look at the book called *Astronomy* in this series for more information as to how distances in space are measured.

What is trigonometry? Why do you think it was invented?

These photographs show two instruments used by surveyors to measure angles. How are these instruments similar to ones you used to measure angles?

Angles In The Air

5

5. Angles In The Air

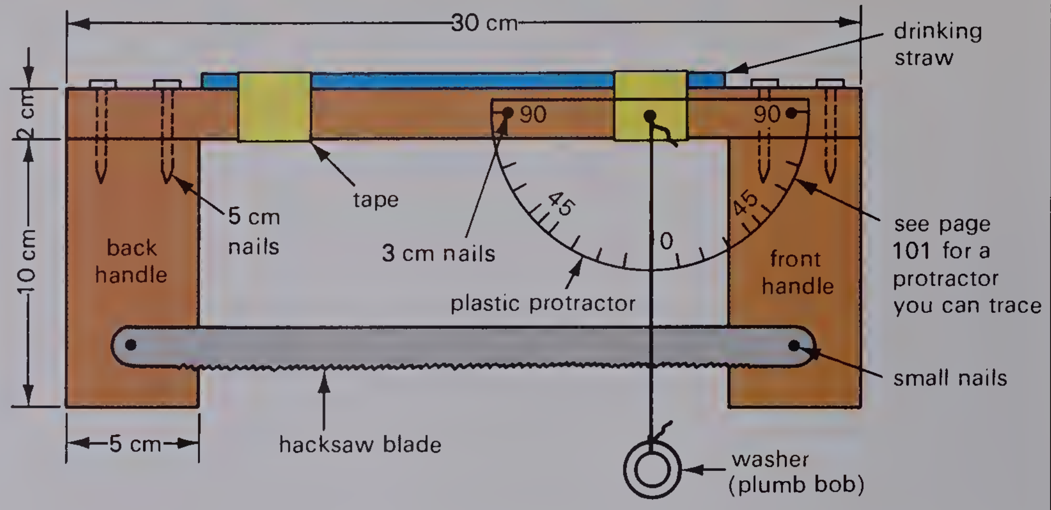
Activity 1:

How can you use angles to measure the height of the school flagpole?

A transit is the name of an instrument used to measure angles along the ground. These are horizontal angles. The opposite to horizontal is vertical. A *clinometer* is the name of one instrument that can be used to measure angles that are vertical or standing up.

Make a clinometer. You will need the following materials:

one block of wood 2 cm wide, 2 cm thick, and 30 cm long for the body;
two blocks of wood 5 cm wide, 2 cm thick, and 10 cm long for the handles;
one drinking straw;
one 30 cm hacksaw blade;
one plastic protractor;
one washer or fish sinker for a plumb bob;
60 cm of string;
two 15 cm lengths of tape;
four 5 cm finishing nails;
six 3 cm common nails;
some white glue;
a hammer.



A Clinometer

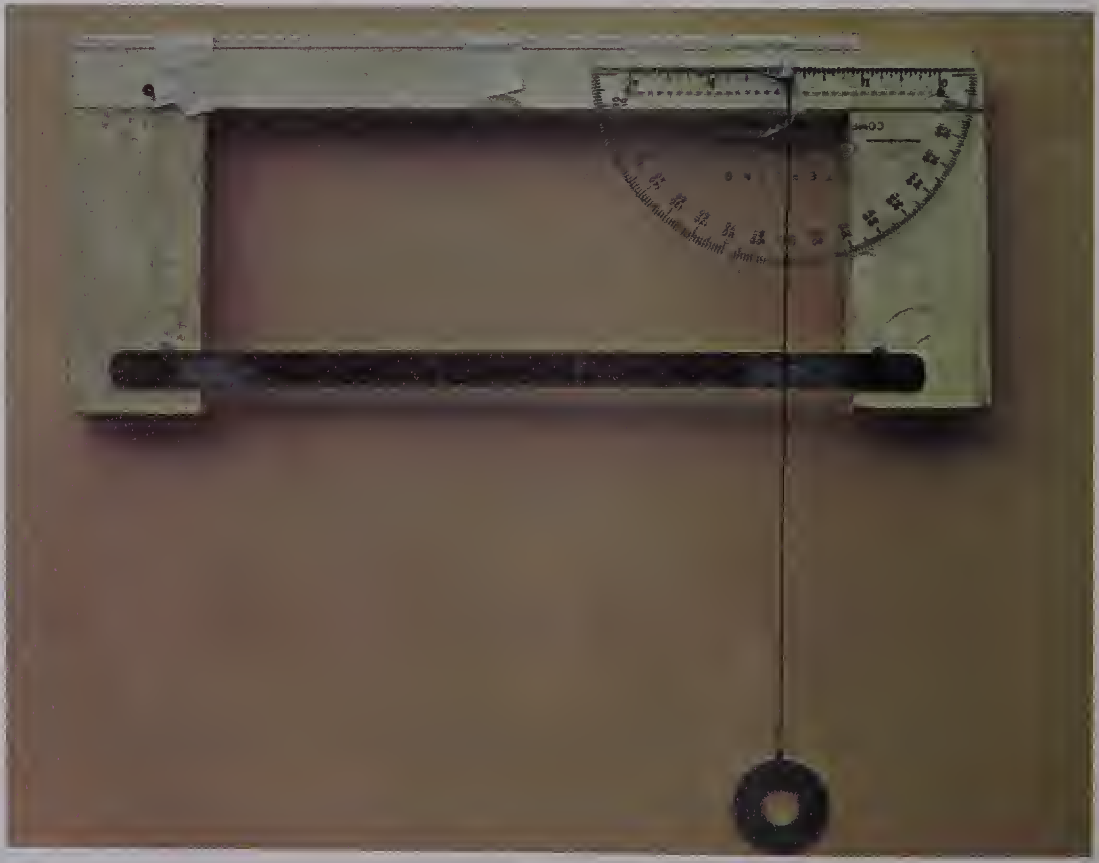
Use the plans and photographs to assist you in putting your clinometer together.

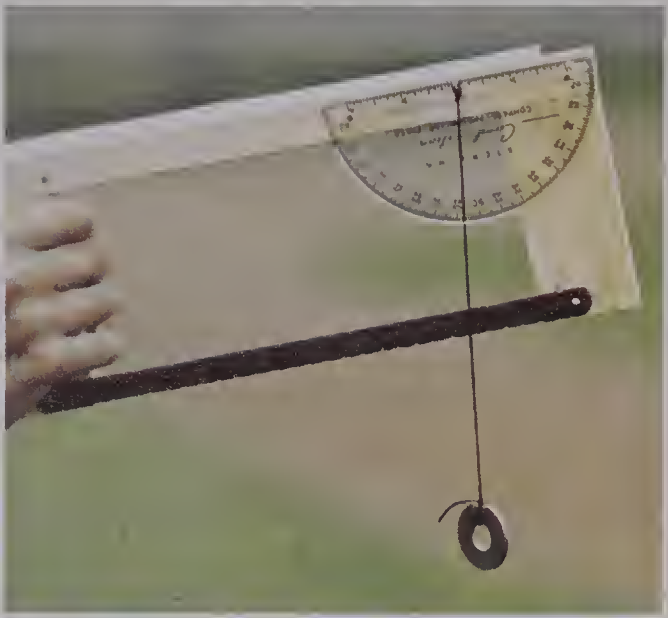
Glue and nail the handles to the body first. Tape the straw along one edge of the body to keep it straight.

Use a nail to drill small holes in the plastic protractor so that it will not crack when it is nailed to the body.

Add an extra nail to the body for hanging the plumb bob when it is not being used.

A completed clinometer.





Now use your clinometer and measuring line to find the height of the school flagpole.

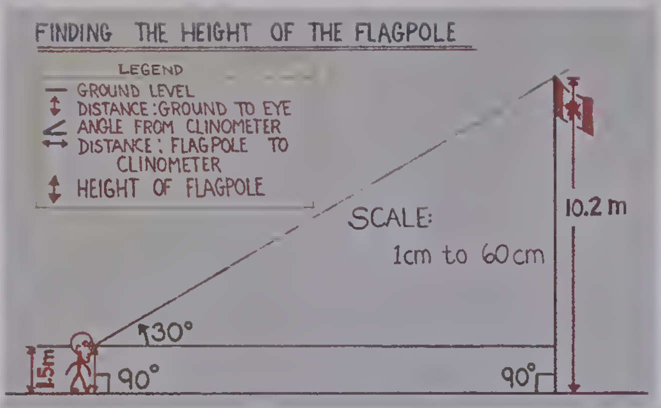
Measure a base line 15 m long starting from the base of the flagpole. Mark the end of the base line. Stand on this mark and face the pole. Hold the clinometer by the back handle and look through the straw so that you can just see the top of the pole in the center of the hole in the straw. Wait until the plumb bob stops swinging. Twist the clinometer over to one side so that the plumb line will catch on the hacksaw blade. Read the number of degrees where the plumb line crosses the scale of the protractor.

To obtain the correct number of degrees for the angle you have just measured, you may have to subtract 90° from the reading obtained. Perhaps you could design a protractor for your clinometer so that you could read the angles directly and not have to subtract.

You could be more accurate if you measured the angle three or four times and averaged the results.

Measure the distance from your eye to the ground. Draw a diagram and mark on it the length of the base line, the average angle, and the distance from your eye to the ground.

Using a clinometer.



In order to find the height of the flagpole it will be necessary to draw your diagram to scale on graph paper. Use the example shown to help you.

Measure the length of the line that represents the flagpole and use the scale that you selected to change this distance into feet.

Digging Deeper

Why would a base line of 3 m be less suitable than one of 15 m for measuring the height of the flagpole?

What would be the length of a suitable base line if you were measuring the height of a 20-storey building?

Why should the angle be measured several times?

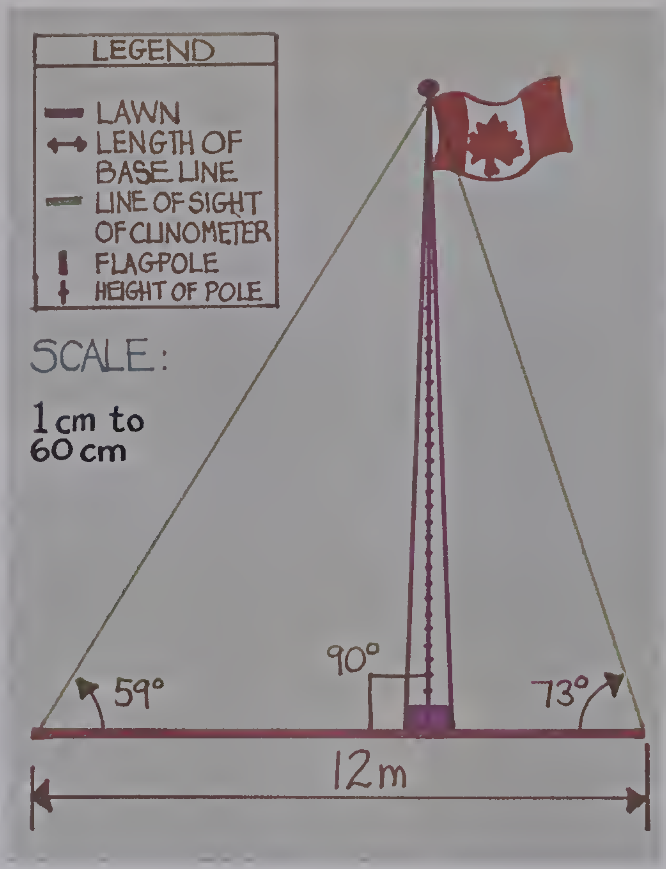
Why could this method not be used to measure the height of a hill?

What part of the clinometer ensured that the base line for the angle would be level?

Would this method work if the ground was uneven or the measuring was done on the side of a hill?

Why might it be necessary to subtract 90° from the protractor reading in order to obtain the correct angle?

What methods for estimating the height of the flagpole could you use to check your accuracy? The book in this series called *Trees* may be helpful to you.



What method was used to find the height of the flagpole in this map?

Activity 2:

How could you map the effects of weathering on the side of a building, using angles?

Rain, snow, frost, and the sun's heat are some of the things that alter the appearance of a building. These changes are called *weathering*.

This activity will be much easier and more fun if you have several friends with clinometers to help you.

Select a suitable wall of a building to map. The wall should be about two storeys high and have most of its parts in a straight line. Look for such signs of weathering as stains from running water, paint peeling, cracks, and bricks wearing away.

Set up a base line parallel to the wall and about 15 m out from it. This base line should extend beyond the wall at both ends and have the zero point even with a corner of the building. Unless you are using your measuring string or a

Where has weathering affected this building?

long tape measure, it will be necessary to mark off your base line into units.

Decide which features of the building will be shown on your map and what parts will need to be measured for height. These points might be the peak of the roof, the tops and bottoms of windows, the edge of the roof at the eaves, or lines which separate one type of building material from another. Make a sketch of the wall showing these features and use this map as a data sheet.

Assign your helpers a station along the base line. Each station will be opposite a wall feature whose height you have decided to measure. Have them use their clinometers, and record their information the same as you did for the flagpole in Activity 1. Ask them to make accurate diagrams and calculate the height of each point measured with the clinometer.

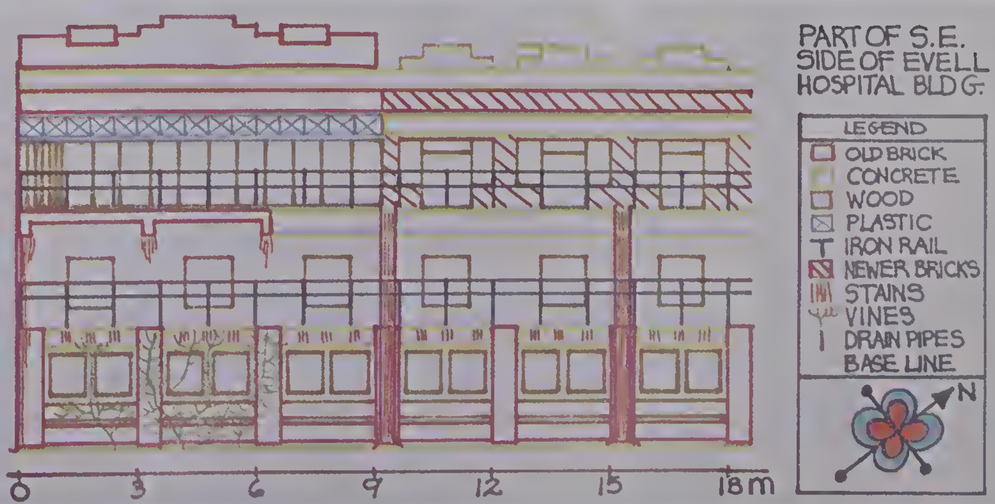
Add these distances to your sketch, along with the locations of the stations and any other distances you will need in order to accurately draw the wall.

Finally, select a scale and make the finished map on a large sheet of paper.

How would you represent on your map the details shown in these photographs?

What steps must be taken at each station along the base line?

Which distances were found using the clinometer and which were obtained using the base line?



Digging Deeper

Why must the base line be the same distance from the wall at all places?

What heights could you measure without using angles?

How could the base line be used to find the length of some parts of the building?

How could you map a tall, curved wall?

How many measurements would be needed to accurately locate a window? a chimney? a large stain? a roof line? a crack?

Which type of material on the wall that you mapped weathered most? least?

How much of the wall's surface area has been affected by weathering?

Branching Out

What could you do to your transit so that it could be used as a clinometer? Try mounting it on the side of a sturdy cardboard box. Be sure that a line passing through the 0° and 180° marks on the scale is parallel to the base of the box. What could be used to check to see that the transit is both plumb and level?

Use your clinometer and measuring string to make a map of a baseball backstop, a large tree, or any other tall object that interests you.

When using the transit as a clinometer, why must the line through the 0° and 180° marks be level with the ground?

Activity 3:

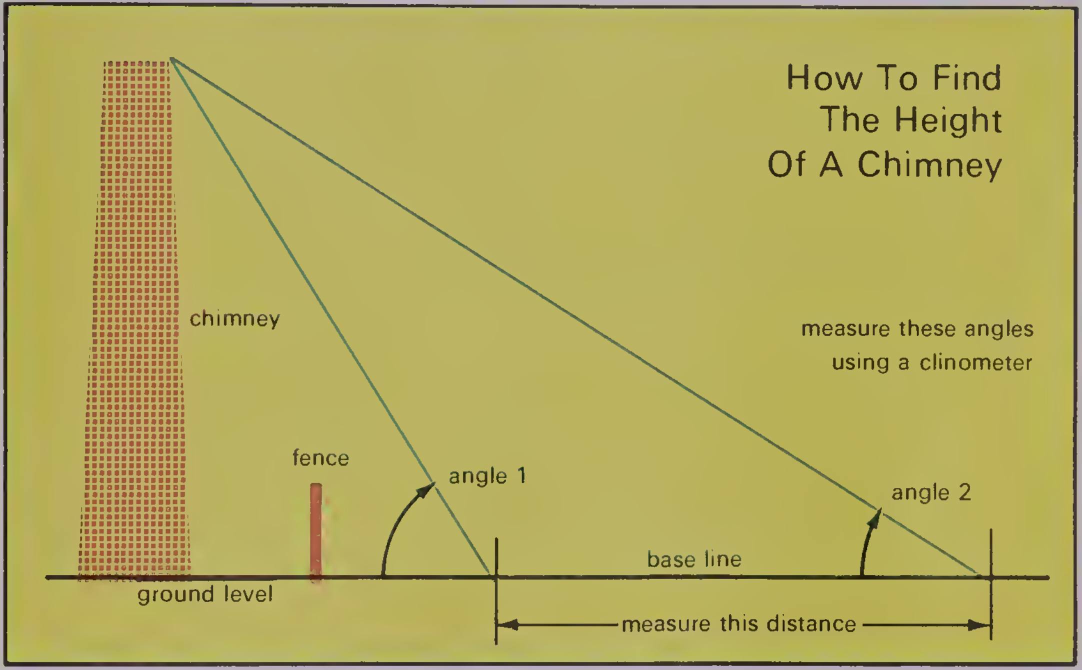
How can you measure the height of an object when you cannot get close to its base?

Suppose that you wished to measure the height of a tall chimney but you were prevented from getting to its base by a barbed wire fence and a NO TRESPASSING sign. You could do the following in order to find the height of the chimney.

Find a level area well back from the chimney and from which you have a clear view of the top of the chimney. Mark the spot on which you are standing. Walk toward the chimney and mark off a base line that points straight toward the chimney. The farther that you are from the chimney, the longer will be the base line that you will need.

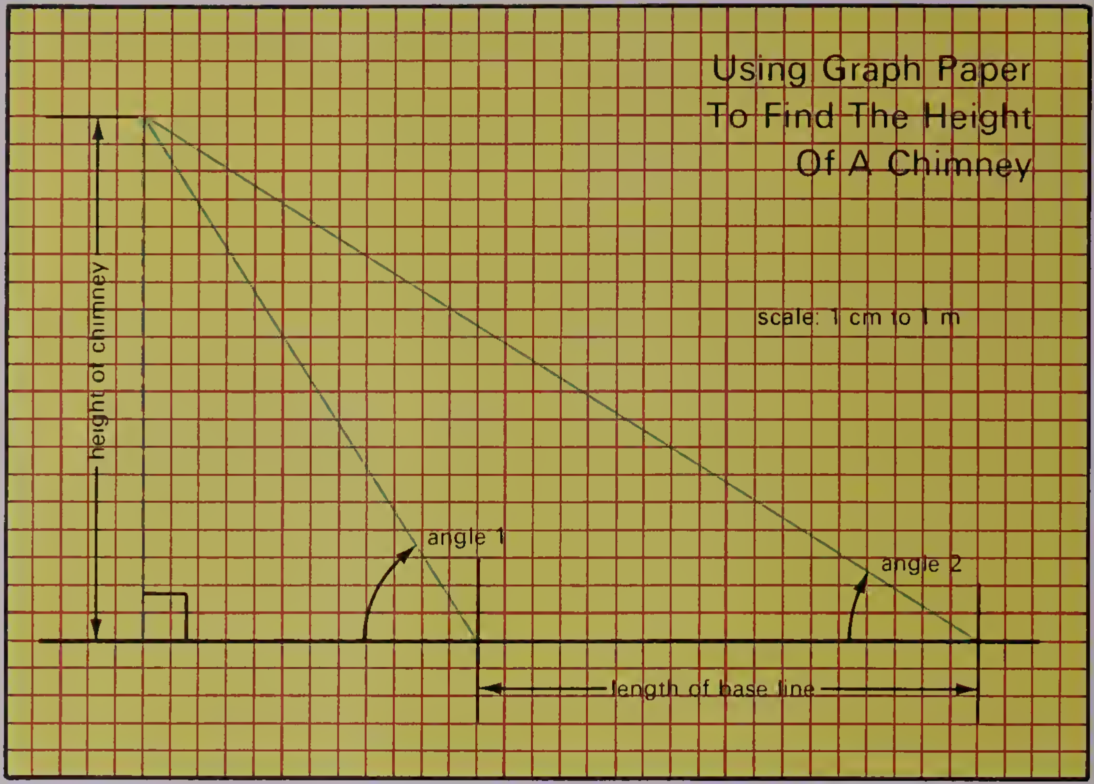
To what tall object does this base line point?

Measure the distance between the ends of the base line. Record this distance and the angles on a diagram.



Stand at one end of the base line and use the clinometer to measure the angle to the top of the chimney. Repeat this procedure at the other end of the base line.

What angles must be measured to be able to calculate the height of the chimney?



Select a scale and use the method shown in the diagram to find the height of the chimney.

Mark off the length of your base line on the graph paper and draw the angles that you recorded. Extend the rays of these angles until they cross. Extend the base line so that you can draw a line from the point where the rays meet at right angles to the base line. The length of this line indicates the height of the chimney.

Digging Deeper

How could a helper be used to make sure that the base line points straight toward the object?

Why does using a very long base line help you to obtain more accurate results?

Which angle should always be larger, the one closest to or the one farthest from the object?

Why would the height you calculated be more accurate if you added to it the distance from the ground to your eye?

What advantage would there be in making your accurate diagram on graph paper rather than on plain paper?

What is the name given to this method of calculating heights?

Branching Out

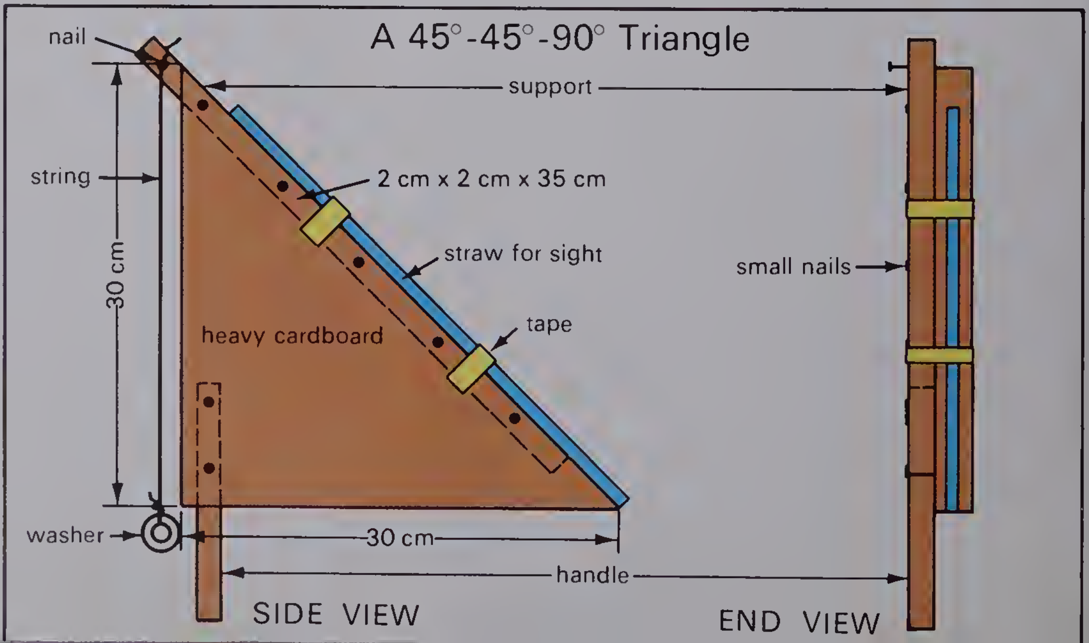
How high is the tallest object that you can see around you? Stand in the schoolyard and look around at the horizon. Which object is tallest; a tree, an apartment building, a hill, or a tower? Stay in the school grounds and use your clinometer to find the heights of those objects likely to be the tallest.

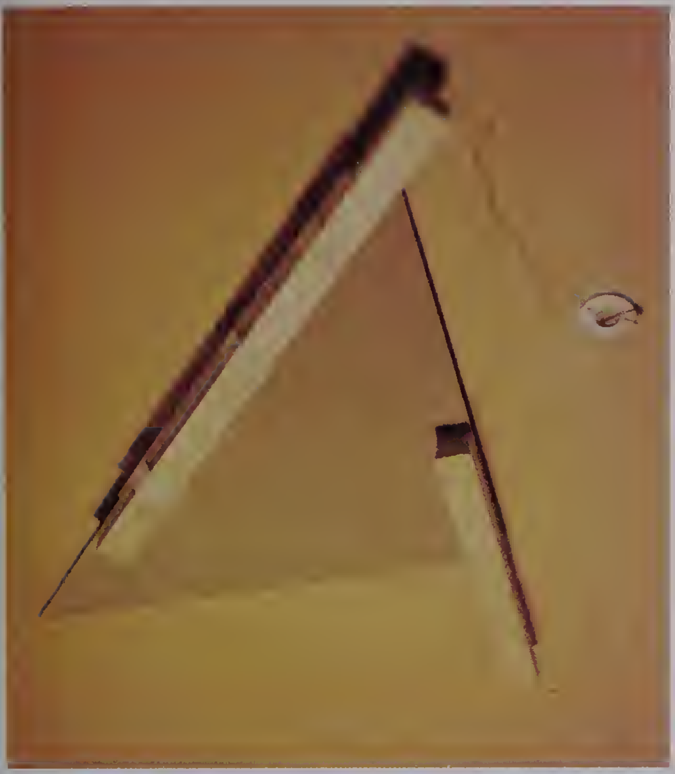
How could two people with clinometers find how high an airplane was flying?

Activity 4:

How tall are the five highest objects on the school grounds?

Instead of using the clinometer, make a *45°-45°-90° triangle.* Use the plans and photographs to help you.





A completed 45°-45°-90° triangle.

You will need the following materials:

- one 30 cm square of heavy cardboard, thin plywood, or Masonite;
- one block of wood, 2 cm x 2 cm x 35 cm for the support;
- one block of wood, 2 cm x 2 cm x 15 cm for the handle;
- one drinking straw;
- ten 3 cm flat-headed nails;
- string and a washer for the plumb line;
- tape;
- a hammer.

You will also need a friend and a measuring string or a long tape measure.

Be sure to tape the sight to one edge of the support first.

Select five things that you think are the tallest objects on your school grounds. These might include the school building, telephone poles, trees, the baseball backstop, or a high fence. Try to guess the height of each object before you use the triangle.

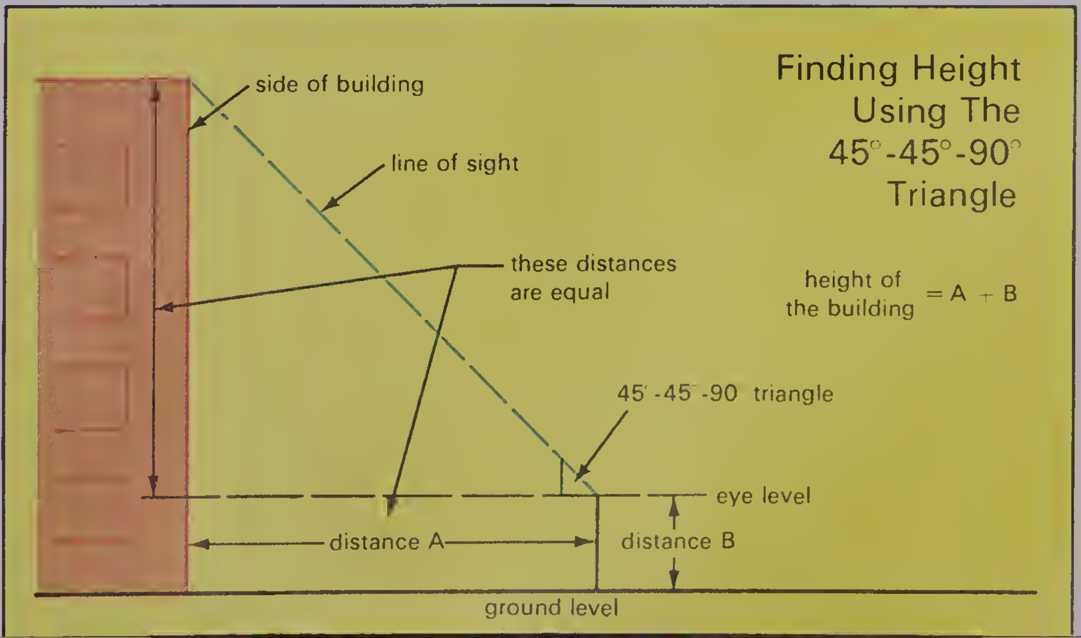
In order to use the 45°-45°-90° triangle follow these steps.

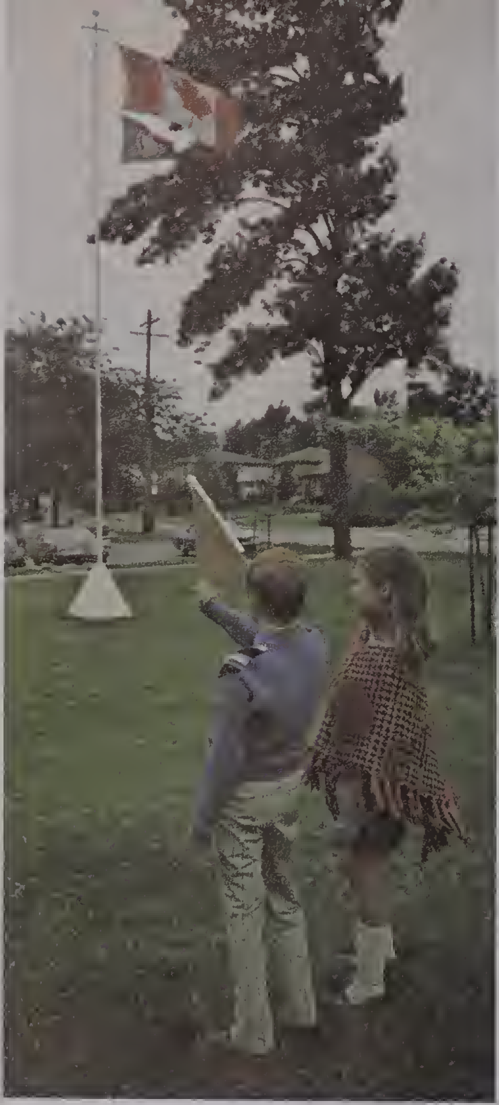
Stand back from the object the same distance that you estimate the height to be.

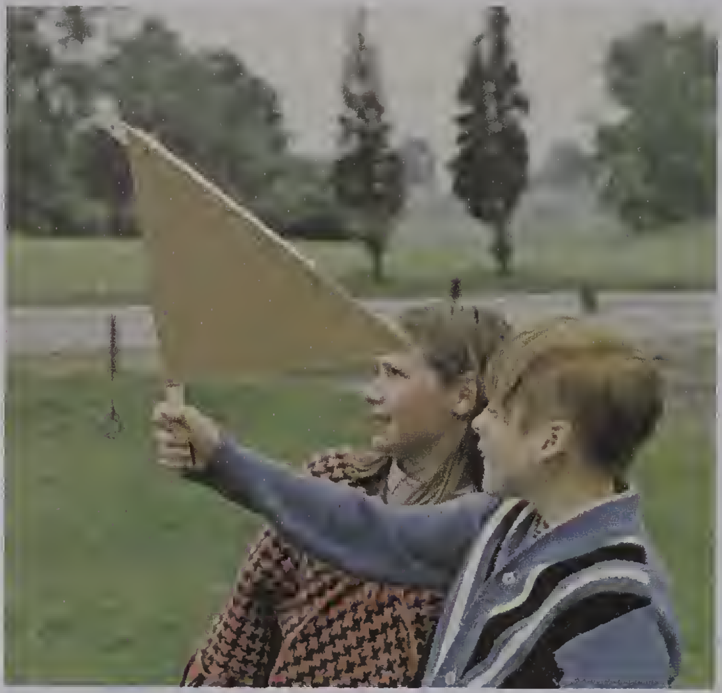
Sight through the straw and walk either backward or forward until you can see the top of the object when you look through the sight.

The plumb line must be parallel with the vertical edge of the triangle. You will need a friend to help you make the adjustments for the plumb line. Use the plumb line to help you in holding the triangle in a vertical position.

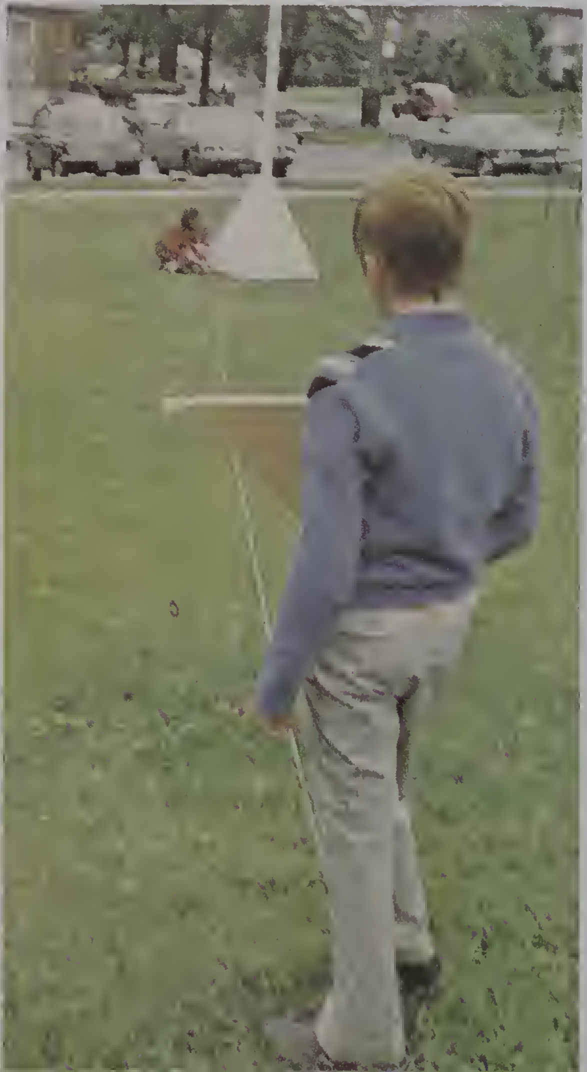
Mark the point at which you are standing. Measure the distance from this point to the base of the object. Also measure the distance from your eye to the ground. Add these two distances. This total is the height of the object.

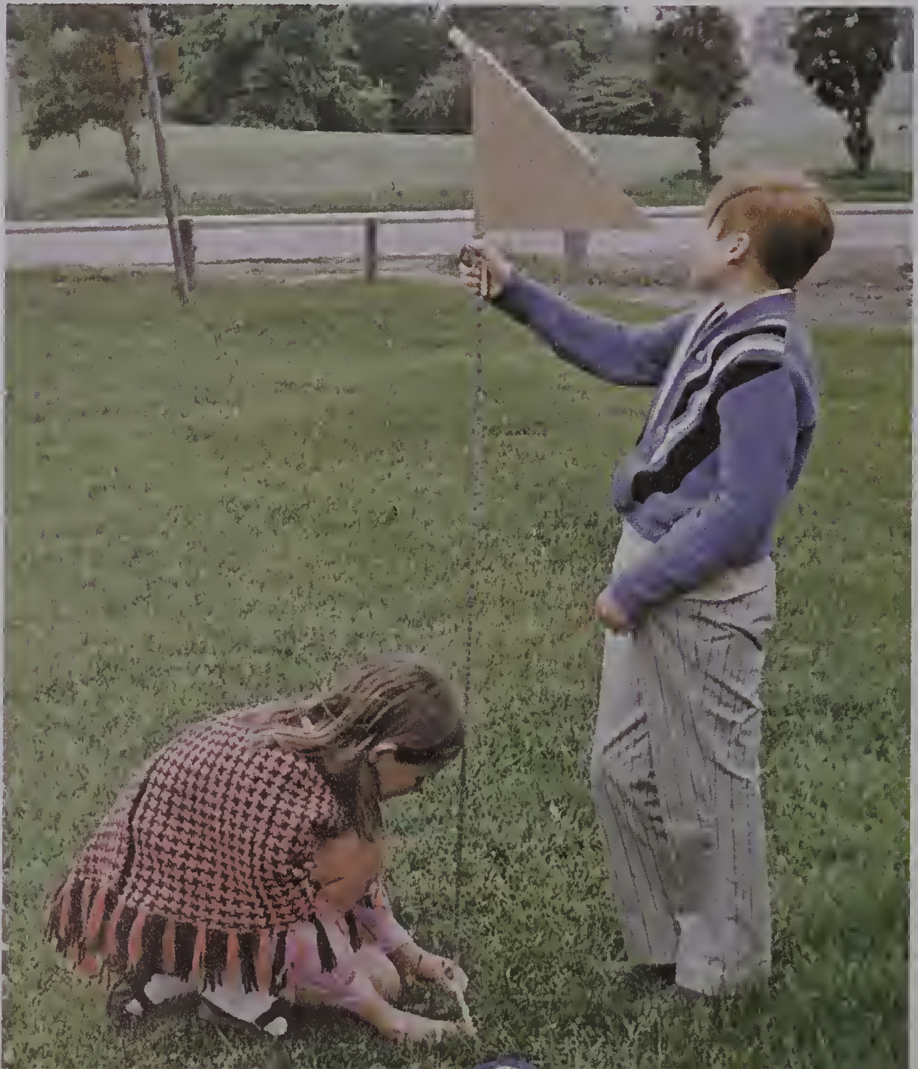

Finding Height Using The 45°-45°-90° Triangle
side of building
line of sight
these distances are equal
height of the building = A + B
45°-45°-90° triangle
eye level
distance A
distance B
ground level

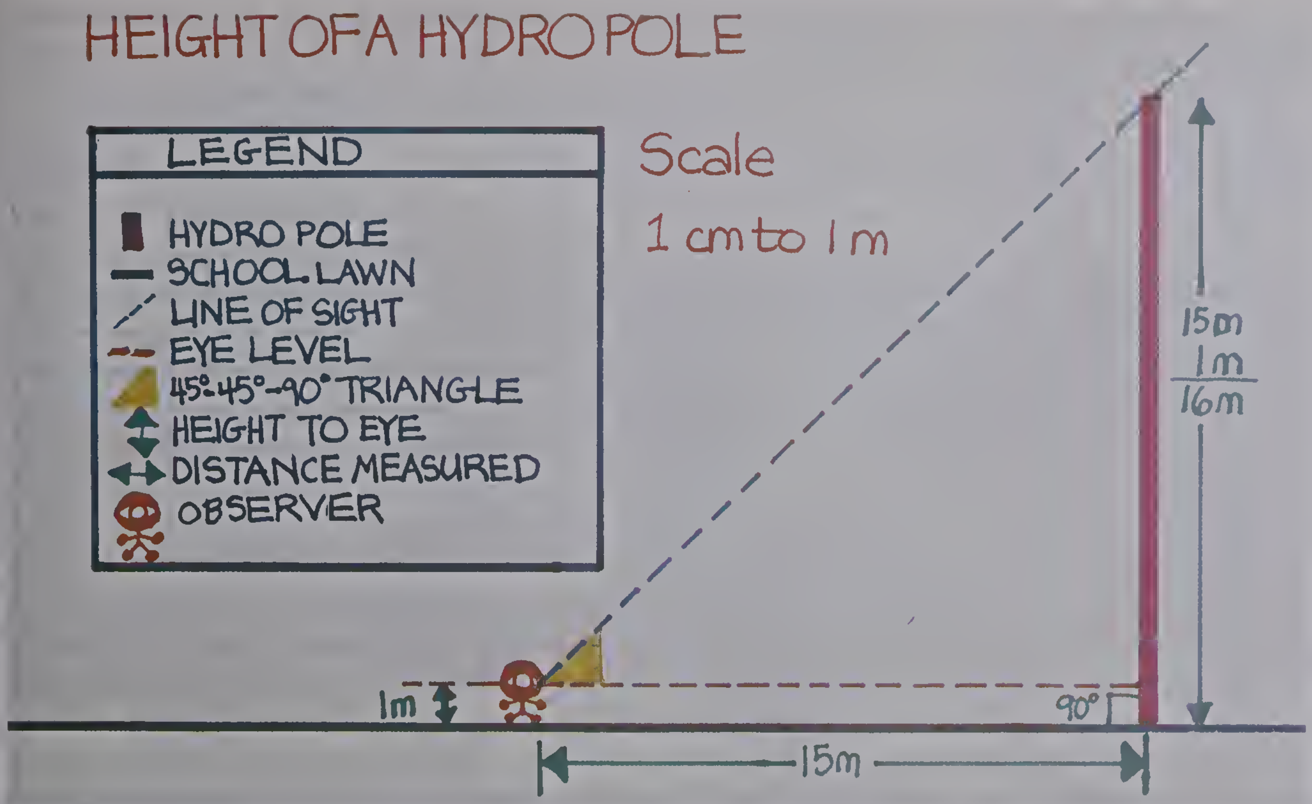




What steps are being taken to determine the height of the flagpole?







How is the scale used in this map to find the height of the power pole?

Digging Deeper

Which object was the tallest?

Which object's height was the hardest to guess?

Why should the ground be level whenever the 45°-45°-90° triangle is used?

Why should several measurements be averaged in this activity?

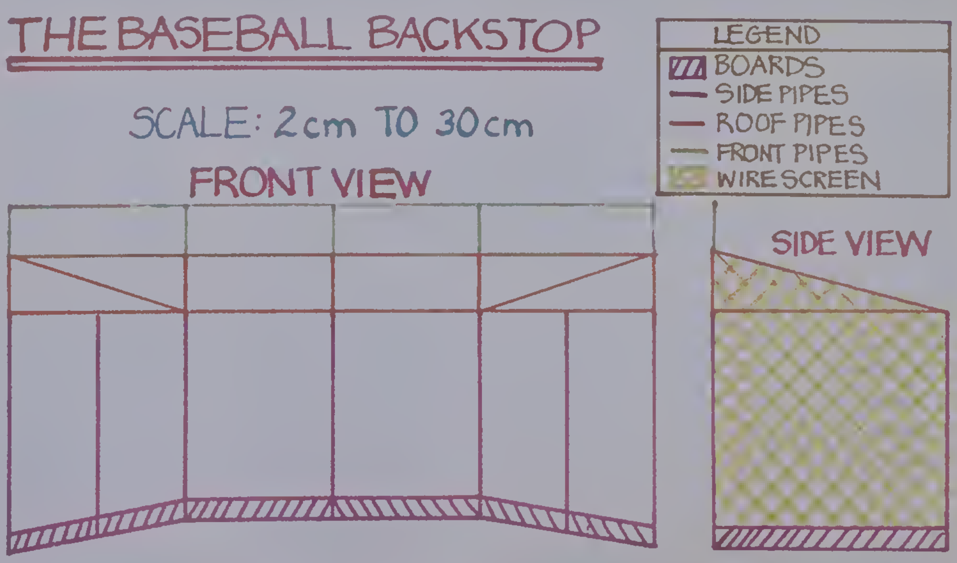
What advantages does the 45°-45°-90° triangle method for finding heights have over the clinometer? What disadvantages?

Why could the 45°-45°-90° triangle not be used in finding the height of a hill?

How could the clinometer be used to check the accuracy of the measurements made with the 45°-45°-90° triangle?

Branching Out

Use the 45°-45°-90° triangle to help you map the baseball backstop, the main branches in a tree, or something else that interests you.



What methods would you use to find the heights of tall objects shown in these photographs?

6

Over, Across, Up And Down

6. Over, Across, Up And Down

Maps which try to show all of the directions—over, across, up and down—on the same map are called *contour maps.*

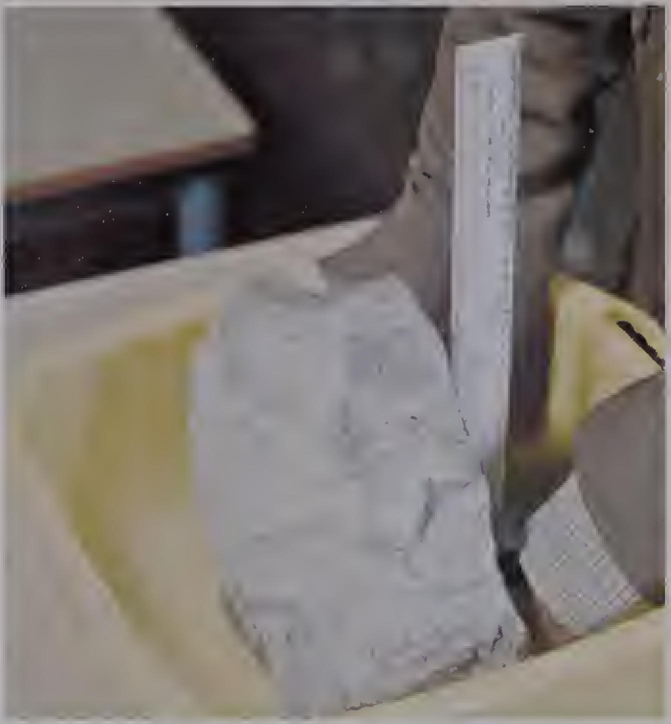
Up to now, the maps that you have made have shown objects only in *two dimensions.* For example, to locate objects in a floor plan map or on the ground, you measured two distances or dimensions for each object. Usually these distances corresponded to length (over) and width (across). In making cross sectional maps, the two dimensions measured usually corresponded to length (over) and height (up and down). But to make contour maps, *three dimensions,* the length, width, and height or, in some cases, depth of each landmark are measured. The method used by surveyors to collect the data from which contour maps can be drawn is called *levelling.*

The surface of the paper on which a map is to be drawn has only two dimensions. But the surface of the ground that is to be represented on the map has three dimensions. One way that is used to overcome this problem is to draw lines on the map that represent heights or *elevations.* These lines are called *contour lines.* A contour line connects points on a map that are at the same elevation.

Activity 1:

What do contour lines show?

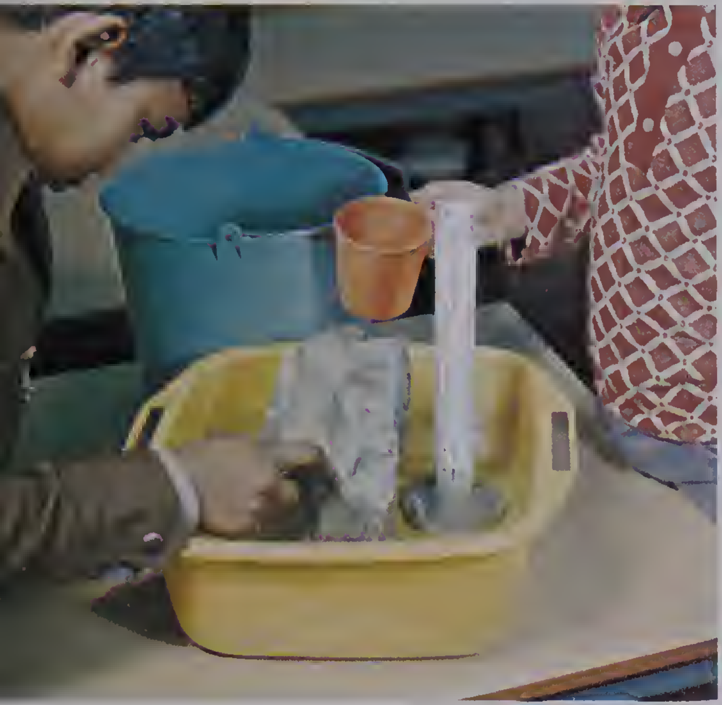
Obtain a plastic pail or dish pan. Find a large rock with an irregular shape and a fairly smooth surface that will fit into the pan or pail.



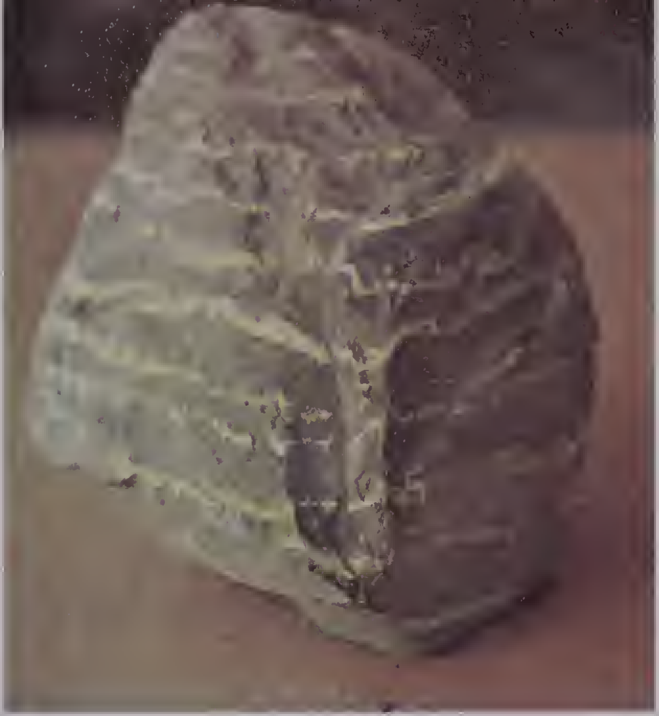
The pan containing the rock and the ruler.

Insert the zero end of a ruler into a ball of Plasticine. Place the rock and the ruler with the ball of Plasticine inside the pan. Mould the Plasticine to the bottom of the pan so that the ruler will stand upright. Add water to the pan, a cupful at a time, until the water level reaches the 2 cm mark on the ruler. Wait until the surface of the water stops moving. Be careful not to jiggle the pan. Use chalk or crayon to mark the water level all around the rock.

Pouring water into the pan.



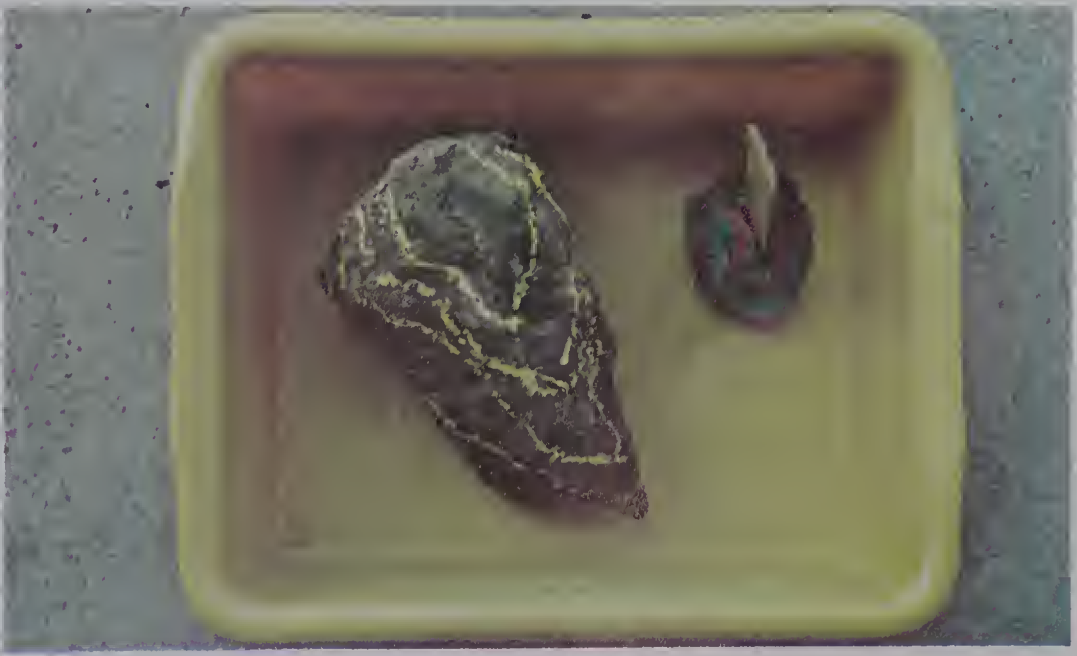
Next, carefully add more water until the level reaches the 4 cm mark on the ruler. Wait until the water becomes still. Then mark the water level on the rock. Repeat adding water and marking the level, until the water covers the rock or threatens to overflow from the pan. Remove the rock and ruler and pour away the water. Place the rock back in the pan until it dries. You may wish to go over some of the lines again in order to make them stand out more clearly.



The contour lines on the rock as seen from the side.

View the rock first by standing on a chair so that your head is directly over the center of the rock and you are looking straight down. The lines that you see look exactly like the contour lines on a contour map of that area. Now place the rock on a table. Lower your head until it is level with the rock. What do you notice about the distance between each line? Number the lines 2 cm, 4 cm, 6 cm, 8 cm, and so on, according to the height or elevation shown by the ruler. The distance on the ruler between each line is called the *contour interval.*

The contour lines on the rock as seen from above.



Digging Deeper

Why was it important to be sure that the surface of the water is still when the lines are being drawn?

How could you prove that the surface of the water was level each time it was raised?

What depth of water was added each time another line was drawn? Was the same amount of water added each time? At which height on the ruler did the longest contour line occur? At which height did the shortest occur?

Which parts of the rock, if any, formed islands?

Where did valleys occur?

Where were the contour lines the closest together? Where were they the farthest apart?

Which side of the rock had the gentlest slope? the steepest slope?

What relationship can you find between the steepness of the slope and the distance between the contour lines?

What pattern of lines would result by adding five measures of water each time, rather than increasing the depth by 2 cm? Would these lines be contour lines?

What could be placed on a map to take the place of the ruler you used inside the pan in order to show the elevation of the contour lines?

How would the pattern have been changed if the ruler had been tilted instead of being straight up and down?

What would the contour interval have been if the lines had been drawn every 1 cm? 4 cm? 7 cm?

Where was the starting point for measuring the contour lines inside the pan?

How would the number of lines change if the lines had been drawn only at the 4 cm levels? Try the activity again to see if you were right.

Branching Out

Look at the topographical map in Chapter 1. Does it contain contour lines? How is the elevation of these lines shown? Where are the highest and lowest places on the map?

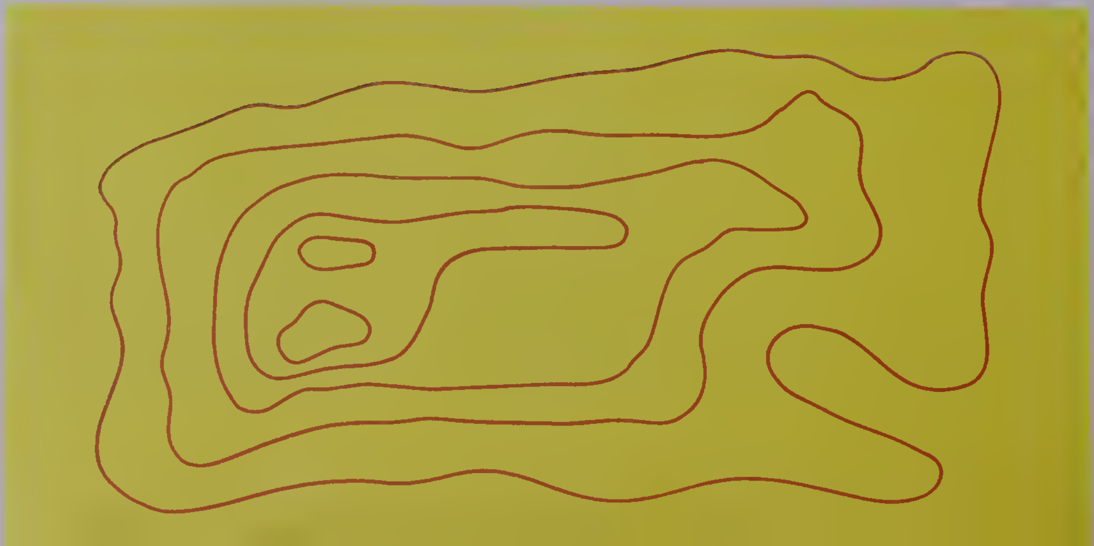
What point has been selected as zero for measuring the elevation of contour lines on topographical maps? What is the interval usually used between two contour lines?

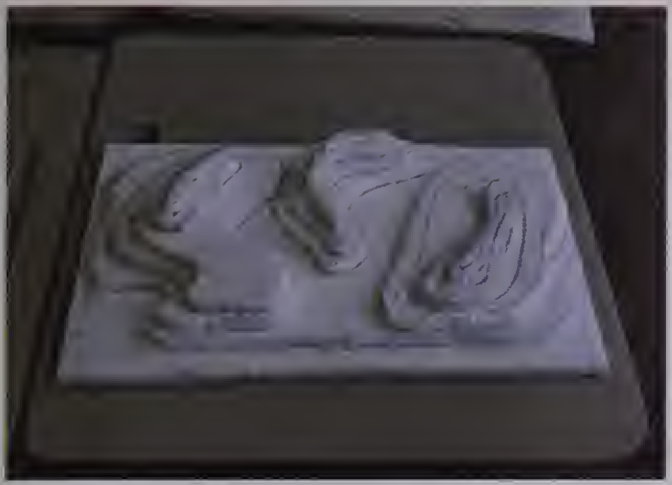
How can you tell what parts of topographical maps are hills? valleys?

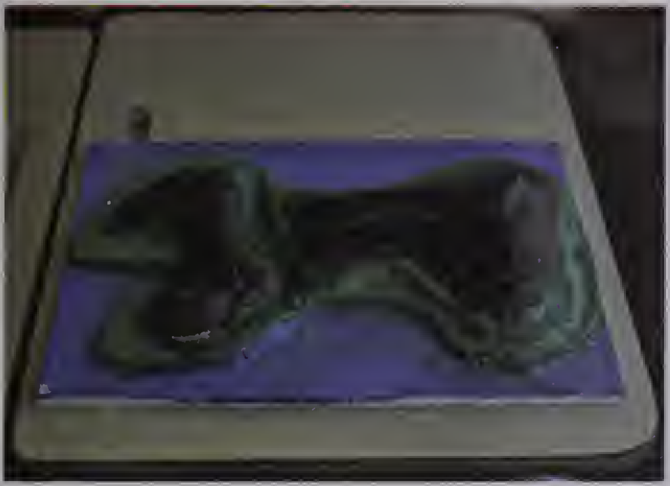
Where is the steepest slope located on the topographical map in Chapter 1?

What other maps in your collection show elevations by means of contour lines?

Draw on a sheet of plain paper some imaginary contour lines similar to the ones shown.



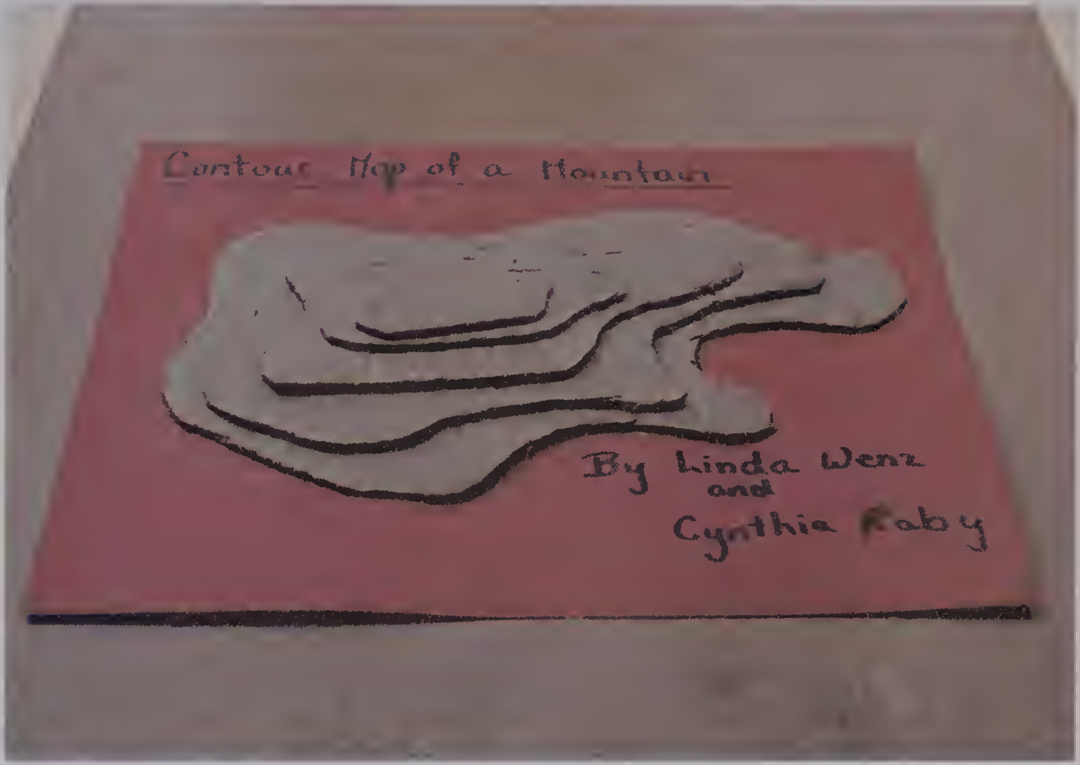




Obtain some corrugated cardboard boxes to cut up. Select a large piece of cardboard to be your base. Start with the contour line closest to the edge of your paper. Cut a piece of cardboard in the shape of the contour line. Fix this cardboard shape to the base with some white glue. Cut out the shape made by the next contour line and glue this shape in the position indicated by your drawing. Repeat this procedure for the other lines. What shape is the finished model? Use the same drawing as before but use materials with different thicknesses to make the shapes. Cut out all the shapes from both styrofoam 2 cm thick and thin cardboard. A lumberyard will sell you enough styrofoam, used for insulating purposes, for about $1.00 and it can be cut with a steak knife. Compare how the shape of the models changed as the thickness of the layers increased.

Using styrofoam to make a contour model.

Coloring the layers of your model.



How does the thickness of the contour layers affect the model?

Making a contour map of a paved surface.

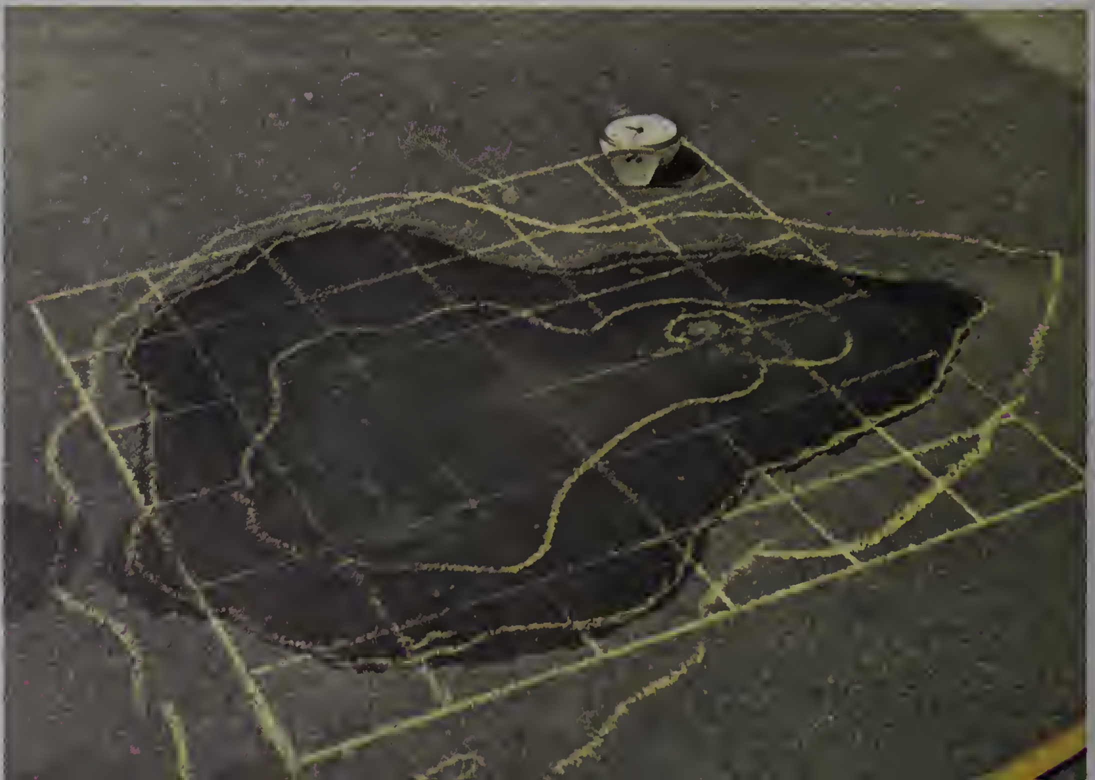
HOW CAN THE SHAPE OF A PUDDLE AS IT DRIES UP BE USED TO SHOW CONTOUR LINES?

Locate an area on the paved portion of a playground or driveway where an interestingly shaped puddle will form. Use some chalk and a metre stick to rule out a grid of 15 cm squares. Carefully pour water onto the area in small amounts until you have a sufficiently large puddle. Use chalk to mark the boundary of the puddle on the pavement. Re-mark the boundary at even intervals of time, such as every half-hour or hour, until the puddle has completely dried up.

Using a large piece of graph paper with 2 cm squares, accurately draw the boundary lines to scale. How are these contour lines different from the ones produced at the beginning of this activity with the rock and the pail of water?

Activity 2:

How can you make a contour map of your school grounds?



In order to collect the data from which a contour map can be made you will need a measuring device called an *aledaide.* In the previous activity, you found that contour lines represented points or parts of landmarks that are at the same level or elevation. An aledaide indicates the position of an imaginary base line that extends outward in all directions and is level in all directions. You also need a ruler, or *rod,* to tell you how much a particular point or landmark is above or below this base line.

Materials needed to make an aledaide and rod.

Activity 2(a):

How can you make an aledaide and a rod?

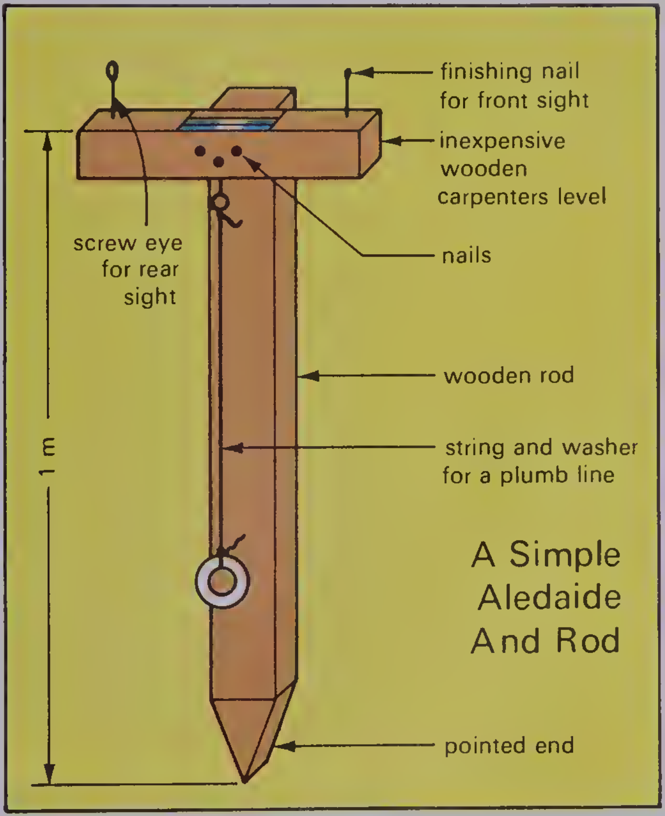
An aledaide and rod can be easily combined into one instrument.

This instrument can be made by nailing an inexpensive wooden level to a stick 1 m long and adding some sights as shown in the diagram.

A plumb line is attached to a screw eye on the bottom of the level.

The rod is pointed at the bottom so that the instrument can be more easily used on a sloping surface.

Be certain that the rod and level form a right angle.


finishing nail for front sight
inexpensive wooden carpenters level
screw eye for rear sight
nails
1 m
wooden rod
string and washer for a plumb line
A Simple Aledaide And Rod
pointed end

Digging Deeper

What two types of information needed in making contour maps can this instrument give you?

What will the contour interval be when the instrument shown is used?

Why should the rod and level be joined together so that they form an angle of 90° with each other?

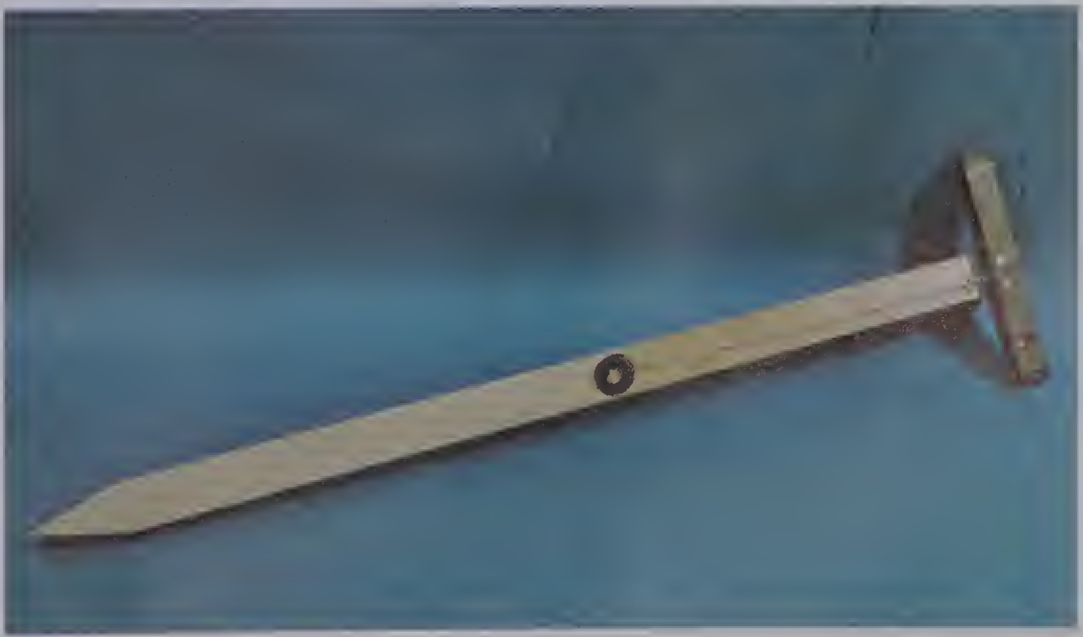
Why should the head of the nail used for a sight be the same height as the center of the screw eye?

Why was the length of the rod set at one metre?

What is the purpose of the point at the bottom end of the rod?

When would a rod longer or shorter than one metre be more useful?

An aledaide and rod.



Area to be mapped.

How is the direction of the measuring line being determined?

Activity 2(b):

How can the aledaide and rod be used to collect data for making a contour map?

Find a small, round hill or sloping area in your schoolyard, a park, or a field nearby. This hill should be at least four times as high as you are.

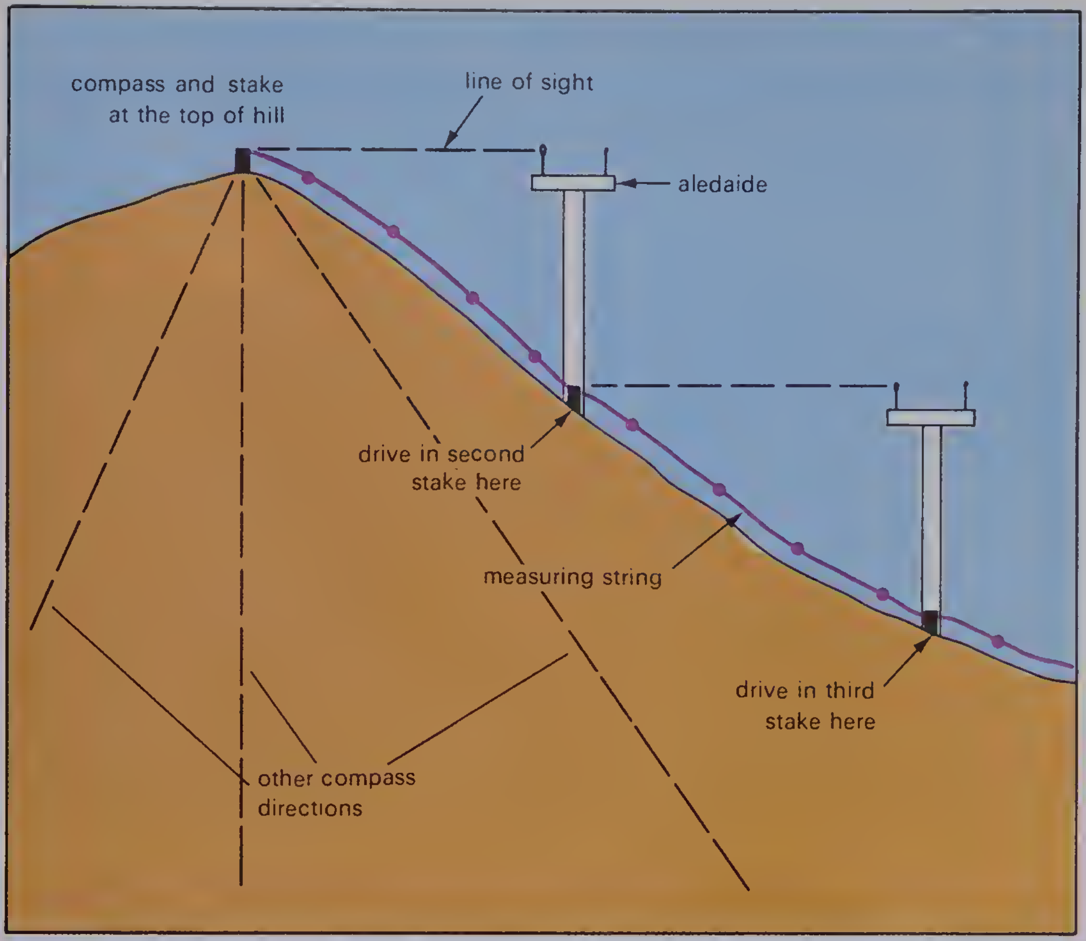
In addition to the aledaide and rod, you will need a measuring line, a compass, five or six short stakes, a hammer, and a friend.

Just as a method for accurately locating landmarks and objects was needed in the other types of maps that you made, a method to accurately locate the points where you measure each elevation will be required.

Drive one of the stakes into the ground right at the spot that you think is the top of the hill. Place a compass on top of the stake and turn it so that the north end of the needle is in line with the letter N on the compass rose. Tie your measuring line to the stake. Ask a friend to help you stretch the measuring line outwards along the ground from the stake in a straight line so that it is pointing to the north.

Using a stake to hold the measuring line in the correct position.

How are these students working together to use the aledaide and rod correctly?



Walk down the hill beside the measuring line until you think the top of your aledaide is even with the bottom of the stake when the pointed end of the rod is touching the ground and in an upright position.

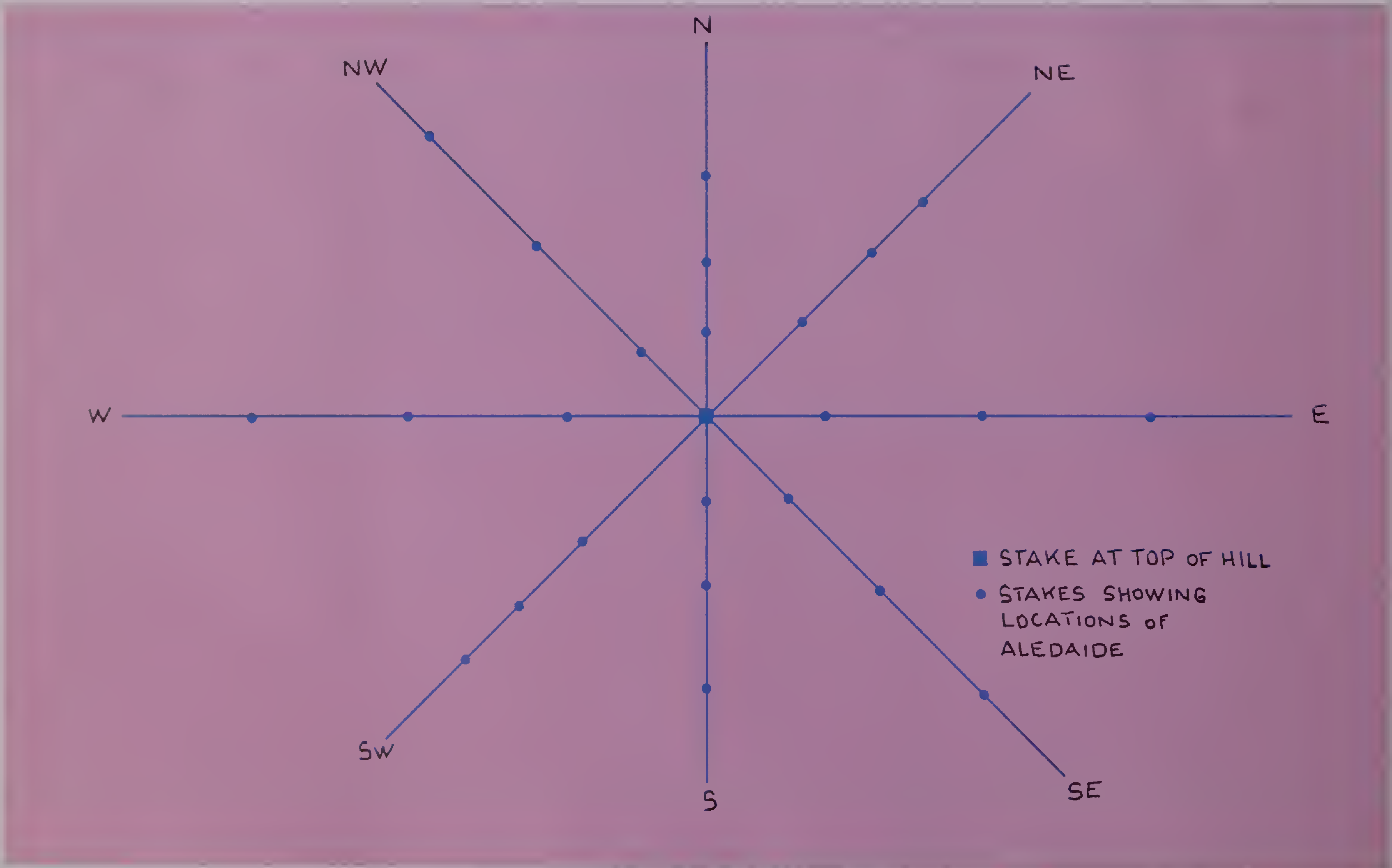
Place the point of the aledaide rod beside the line so that you can see through the sights the bottom of the stake used to mark the top of the hill. Have your helper check to see that the bubble is in the center of the level and the plumb line is hanging parallel to the side of the rod. You may have to move the point backwards or forwards along the line in order to properly line up the sights, the bubble, and the plumb line.

Mark the position of the point of the rod by driving in another stake. Move farther down the hill and line up the aledaide so that you can see the base of this second stake. Continue making sightings and driving stakes until you reach the bottom of the hill.

Recording the locations of the stakes that marked the positions of the aledaide and rod.

Measure the distance between the stakes using the measuring string. Record this information and then move the measuring string so that it is pointing towards northwest (NW). Use your aledaide to locate and then drive in stakes along this line, using the same method as you did for the line pointing north. Repeat this activity in the other compass directions: NE, E, SE, S, SW, and W.

The information, when placed on a data sheet, might look like this.



Make a map from the information you recorded on your data sheet. Obtain a large sheet of paper. Draw on it the lines representing the compass directions using a ruler, a protractor, and a pencil. Select a scale. Measure and then mark on the points that represent the location of your stakes.

First join up all the points where the first stake was placed along each of the direction lines. Next draw another line joining up all the points where each of the second stakes were located. Draw a line to join the third stake positions, and so on.

Add a scale line or statement, a legend, a title, a compass rose, and other parts you know your map should have. Starting with the line farthest from the top of the hill, mark on the elevation of each contour line in a manner similar to that used on the topographical map shown on page 13. Finally, outline the contour lines with magic marker and then rub out any lines or marks such as the compass direction lines that were only used to help in locating points.

Digging Deeper

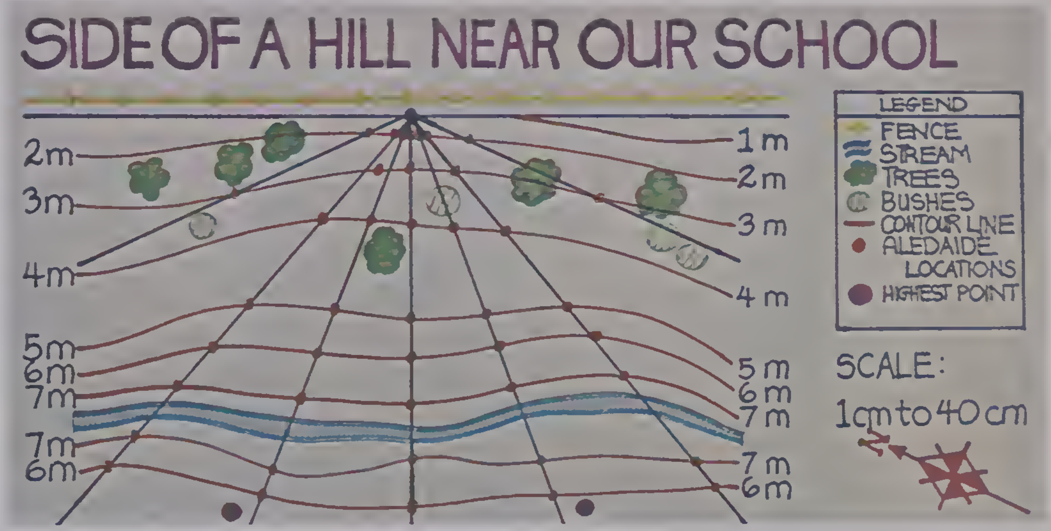
What was the contour interval used on this map?

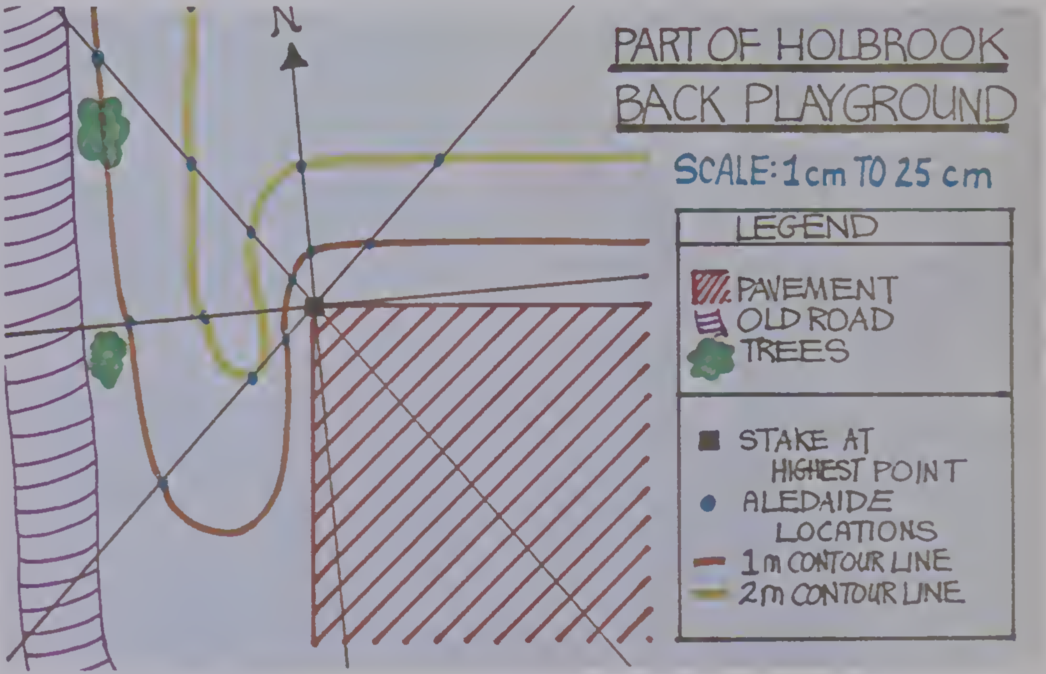
In what places on the map do the steepest slopes occur?

What is the elevation of the top of this hill?

If an object such as a stone, sewer, or curb does not occur right on a compass direction line, how could its elevation be shown on your map? How would you find the elevation of an object that was between two of your aledaide locations?

How will the distance you travel horizontally and the distance you actually travel change when you go up or down a slope? How might this affect the accuracy of the distance between the aledaide locations? What effect could this have on the accuracy of your map?





Contour maps made from data collected with an aledaide and rod.

If contour lines had been used to fill out the spaces in the corners of the map, what would the lines look like? Where would they join up? Must the contour lines always form a closed figure or shape?

Branching Out

Collect and examine a number of contour maps.

Remember that contour lines are symbols. What do these symbols represent? Is the symbol used for contour lines usually the same on every map?

What type of legend is often used to help explain the contour lines?

What other types of information could be placed on contour maps in addition to the contour lines?

What other methods are used to show elevation on maps? What method is used when the area mapped is very large?

How are the elevations placed on contour maps that show elevations below sea level?

What elevation has been chosen to represent sea level?

What marks are added to contour lines to show whether the landmark is a hole or a hill?

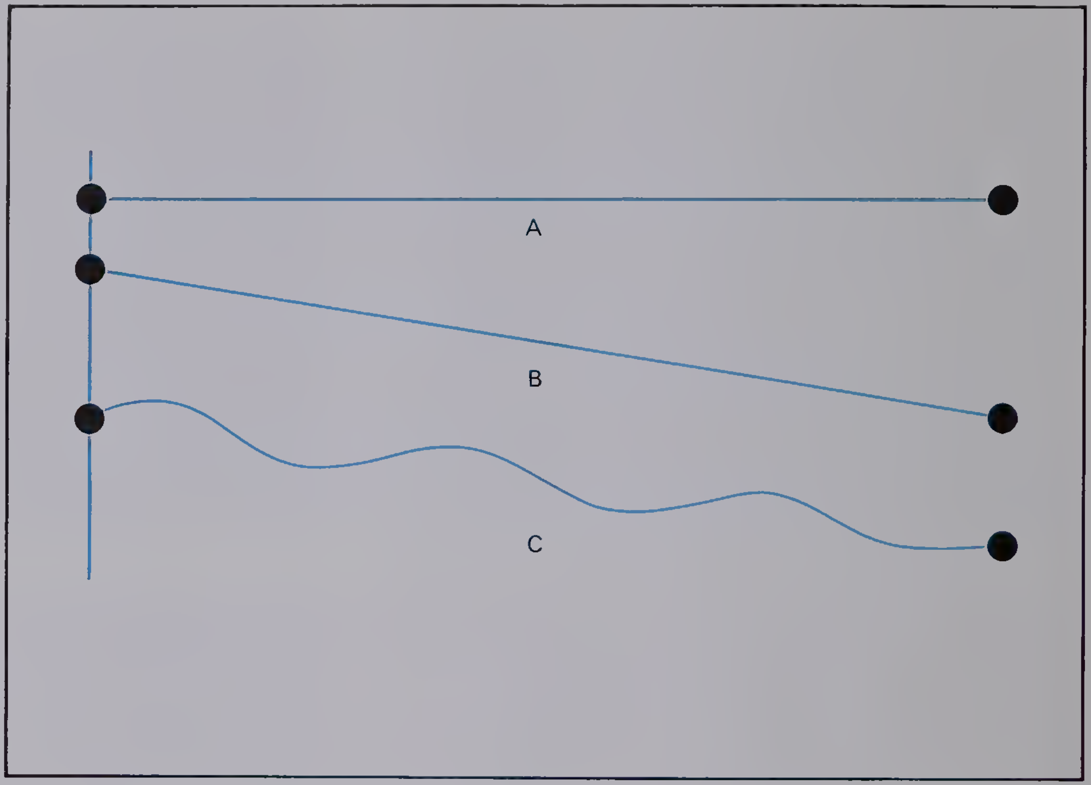
Use the aledaide to help you add contour lines to a map that you have already made.

Visit the City Engineer's Department, a building contractor, or a land surveyor. Ask politely to look at some real transits, aledaides, rods, and chains. Find out how the levelling method is used to test to see if the foundation of a building is level. Examine some maps in which information obtained by levelling has been used.

What are bench marks? How are they used?

Use cardboard layers to make a model of an area from the lines on one of your contour maps.

Think of some things that might be related to the elevation of the land. Some of these features might be temperature, moisture in the soil, type of soil, and type of plants. Make a contour map of an area that interests you. Take tests at various points and show this information on the contour map. Look for places where the elevation and information match.



Which distance is longest?

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An informative account of the story of maps and their makers through the ages.

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A collection of maps from the National Map Collection showing Canada's history from the 16th Century to the present.

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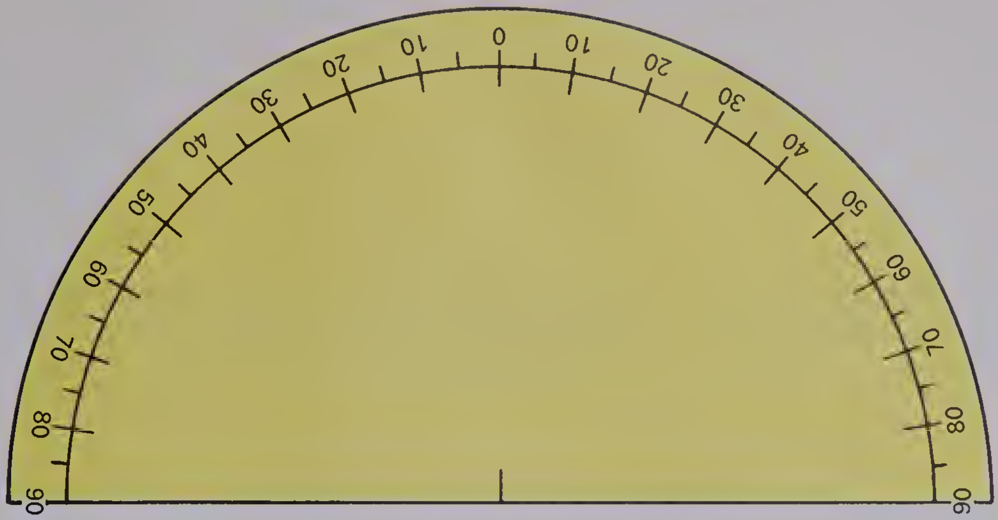
A community is mapped to demonstrate the use of symbols.

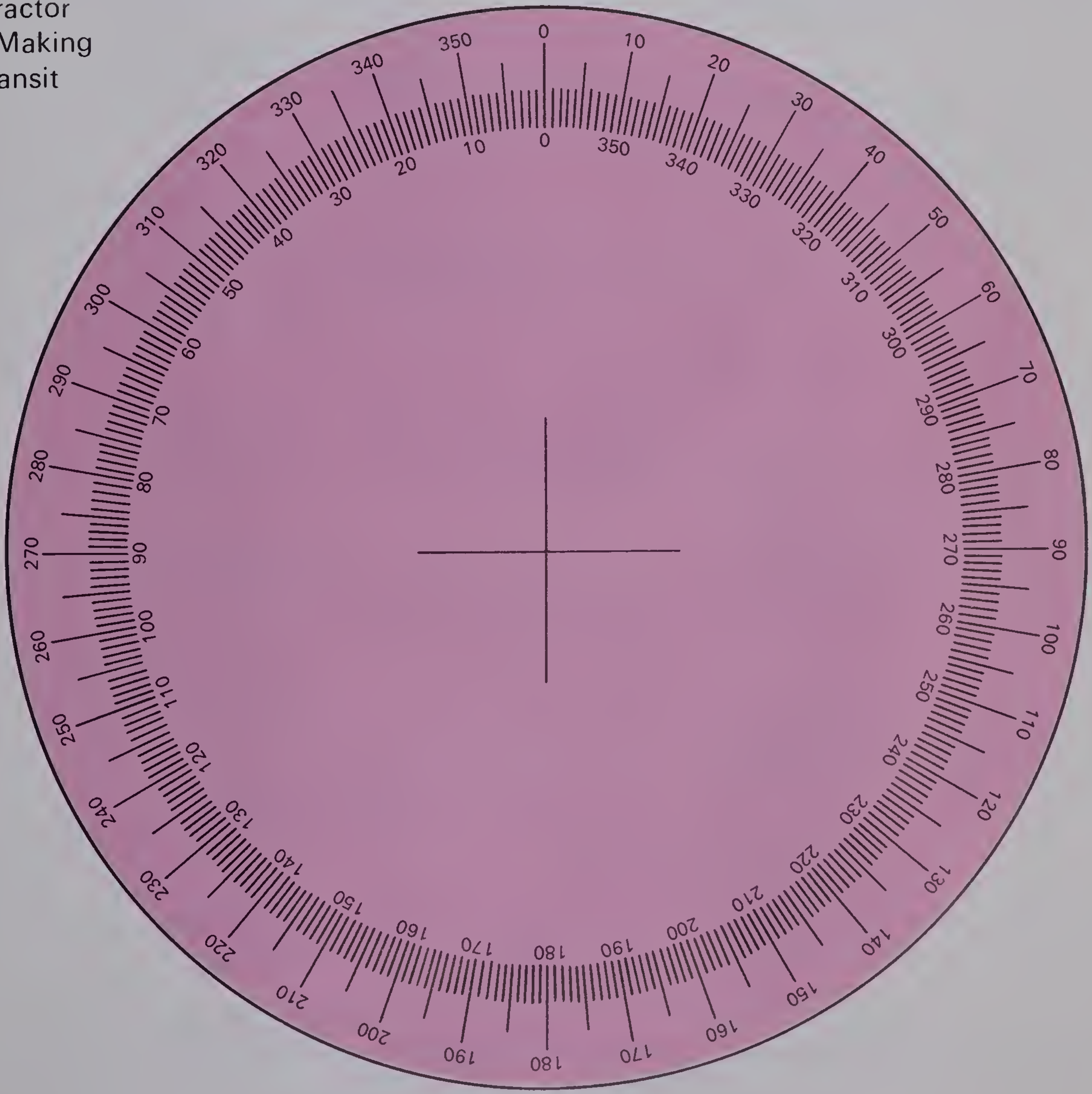
Maps of our school. (Motion picture.) Bailey Films, 1965.

As an exercise in mapping skills, a class maps their classroom and their school.

Protractor
For Making
A Clinometer



Protractor
For Making
A Transit



Glossary

Aledaide: A surveying instrument used in mapping contours, consisting of a ruler with sights and a level.

Base line: A straight line drawn on a map or marked out on the ground from which all other measurements can be made.

Bench mark: A point where height has been accurately determined, and probably found cut in walls or the sides of buildings.

Cartographer: A person who makes maps.

Compass: An instrument used to measure direction in which a magnet (called a needle) inside a case swings or pivots. The needle always comes to rest so that the north pole of the magnet points to the North Magnetic Pole of the earth.

Compass card: The floor or dial of a compass which has been marked to show the directions: north, south, east, west, and so on.

Compass rose: A compass card shown on a map to show which direction is north. Some compass roses are very elaborate.

Contour: The outline of the shape of an object.

Contour line: A line drawn on a map which connects all points that are at the same elevation.

Dimension: Any length, width, or height, that can be measured.

Elevation: The height of an object above a certain point. On maps, the elevation of an object is the height above sea level.

Grid: An arrangement of evenly spaced parallel lines that divide a map or chart into squares.

Landmark: An easily recognizable feature or object on the surface of the ground.

Legend: That part of a map which explains some of the symbols used to represent the landmarks drawn on a map—a map key.

Level: Horizontal.

Level: An instrument used to determine if the surface of an object is horizontal or level.

Levelling: The art of making measurements when a level is used.

Line level: An instrument that can be attached to a string or a line in order to make it level.

North Magnetic Pole: The ends of a magnet are called poles. Each magnet has a north and a south pole with the magnetic pull being strongest at these two places. Likewise, the earth is a ball-shaped magnet having two places where magnetism is strongest, the North Magnetic Pole and the South Magnetic Pole. The North Magnetic Pole is situated in the Arctic near Ellesmere Island.

Offset: The distance measured perpendicular to a base line from an object.

Offset line: The line drawn on a map and used to represent an offset distance.

Offset string: The instrument used to measure an offset.

Orient: To move or position an object so that some part of it points in the direction of north.

Orienteering: The sport of finding one's way over a given course using a map and compass.

Perpendicular lines: Lines which form an angle of 90° to each other.

Pivot: A fixed pin on which something turns.

Plan view: A drawing showing the view one would see if they looked straight down at an object from above.

Plotting: Transferring the information from the data sheet to the paper on which the map is being drawn.

Plumb: To find if the surface of an object is exactly vertical (straight up and down and not tilted).

Plumb bob: The mass used at the end of a plumb line.

Plumb line: An instrument used to determine if a surface is plumb.

Points of a compass: The 32 equal divisions of a compass card: N, NNE, NE, and so on.

Political map: One which shows boundaries that separate areas of government such as city or town, county, province or state, and country.

Relief map: A map which shows the contours, elevations, or unevenness of the surface of an area.

Representative fraction: A method of indicating the scale on a map in which the units are not given. (Also called rational ratio).

Resource map: A map that shows the location or availability of minerals, manufacturing, farming, and other products or activities of an area.

Right angle: An angle formed by two perpendicular lines and measuring ninety degrees.

Scale: The relation between the actual size of something and its size on a map, a plan, or a drawing.

Scale line: A straight line that has been conveniently divided into units so that you can use it to measure distances on a map.

Station: A particular location along a base line or transect line from which measurements are made.

Survey: To determine accurately the boundaries or contours of the objects in an area by measuring the lengths of lines and the sizes of angles.

Surveyor: A person who carries out the surveying of an area.

Theodolite: A surveying instrument used to measure horizontal and vertical angles.

Transect line: A string or rope used to cross some particular area and form a base line for measuring that area.

Triangulation: A method by which the lines and angles of a triangle are measured in order to find distances between objects.

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Pollution
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